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Getting Out of the Rut

IN most power plants the recurrence of routine work tends to get the engineer in a rut. Unless he guards against it, he is likely to become too easy-going.

Yes, reader, we are prepared to hear that *your* conditions are not such. In addition to your regular duties, you never know when you may be called upon to repair a trap or show the engines to visitors. But, with all these distractions, isn't it true that a good many hours each month vanish without much to show for them, other than a well kept station log and a clean slate so far as breakdowns or stops of apparatus are concerned?

How can one overcome the habit of letting time slip away without doing any more than the least necessary to keep the plant in good condition? The secret is contained in five words, DON'T LOAF ON THE JOB! True, most of us have to make a big effort to work harder than we absolutely have to; but the fellow ambitious to attain unto large responsibilities and their commensurate rewards, never gets there and *stays* unless willing to sacrifice temporary comfort to future welfare.

Some engineers find the days too short for all that needs to be done. But, on the other hand, there are countless installations where the productive "load factor" of the engineer as an efficient personality is far below what it might be in relation to his mental and ultimate financial advancement.

To "get down to brass tacks," here are some of the practical ways in which a man can lift himself out of the rut and get a firmer grip on the rear platform rail of the Prosperity Limited as she slows down a bit in passing his station.

First: Make a closer study of the plant itself. Take a few photographs of the interesting features, if you are a camera enthusiast, and frame one or two and show them to the "boss." Keep a few extra unmounted prints in the drawer for visiting friends and the representatives of the engineering periodicals, who may happen in in search of a story. If a scale plan of the installation is not on hand or up to date, make one on tracing cloth so that blue prints may be made when needed. Then try your hand at an elevation or section. Get some loose-leaf sheets and make simple diagrams of all piping and valve relations, and do not forget to make a quick reference list of every piece of machinery in the plant, giving its size and capacity, make, floor space, and other particulars likely to be desired "off the bat" by the general manager. Get permission, if possible, to go through the office files and read every letter bearing upon your department, and if your enthusiasm is still good, start a file of your own which shall be run with the object of becoming the best source of complete information on the plant around the premises. Last, but not least, overhaul your desk and see that it stays in order and that the technical journals which come in are at least removed from their wrappers and put in chronological order in an accessible place.

Second: Appoint yourself a committee of one to study plant efficiency. If you cannot get authority to make improvements needed do not forget them, but get them down in black and white for future reference. See that your logs compare favorably with those of similar plants elsewhere and "get the load-curve habit." To improve the operating economy is your most important duty next to giving continuous service. Remember, you may be called upon some day to show the owner why he should continue to run an isolated plant instead of buying outside service. If he should, you must be prepared for keen, close questioning which must come in such cases.

Third: Read at least one technical journal regularly and attend local engineering society and club meetings which bear upon your special practice. If the manager sees an engineering paper on your desk he is not likely to think that you are wasting your idle moments. Visit other plants in your territory; learn to write grammatical, straightforward letters and reports; ask the public library to buy the technical books you think you ought to have and in general open up the doors and windows of your personality to let in the light of outside practice and the invigorating fresh air of other men's views and interest.

In a nutshell, realize that you live in an age of opportunity, and reach after fullness of life in every direction associated with your calling.

[*H. S. Knowlton, Newton, Mass.*]

Lazwell Drainage-Pumping Plant

SYNOPSIS—This pumping plant is used to drain an area of approximately fifty thousand acres of swamp land. Three Lentz condensing engines are directly connected to three 54-in. centrifugal pumps. Three water-tube boilers with induced draft supply steam at 150 lb. pressure, superheated 125 deg.

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While vast areas of swamp and overflowed land in the United States have been reclaimed there remain upward of 75,000,000 acres to be drained and about 150,000,000 acres that require more thorough draining to make them more productive. Over half of the as-yet-undrained land lies in the Mississippi Valley, where pumping is necessary in many places because the land lies below the river level.

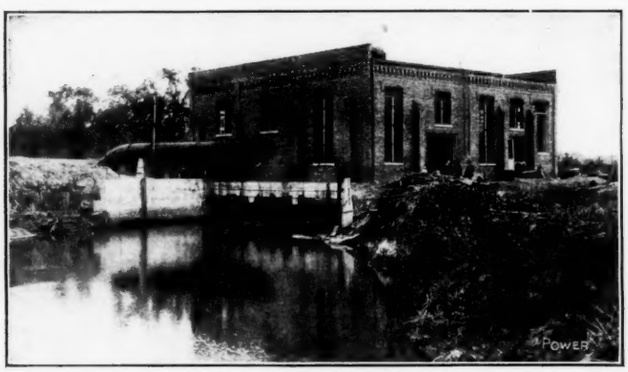

FIG. 1. GENERAL VIEW OF THE PUMPING PLANT AND SUCTION BAY

The principal parts of the problem of drainage by pumping are: First, the design of the pumping plant to produce reliability of operation, economy in operation and low maintenance; second, the maintenance and operation of the plant in a manner to insure reliability and the best possible plant efficiency under the various conditions of pumping head.

The Lazwell plant of the Des Moines County Drainage District No. 1 is a good illustration of a modern plant, laid out and operated to satisfy these factors.

The plant is located about nine miles north of Burlington, Iowa, on the west bank of the Mississippi River and drains a district embracing 50,000 acres, extending from Burlington to Oakville. The general view, Fig. 1, shows a part of the suction bay and one of the discharge pipes extending over the crest of the levee. As induced draft is used, the chimney extends but 10 ft. above the roof. The one-story building is 32 ft. high, and 70x80 ft. in area. The walls are of common brick and the roof is of tar and gravel over flat arch tiles supported on steelwork. A 12-in. transverse partition wall divides the building into an engine room, 37 ft., and a boiler room, 40 ft. wide.

There are three 54-in., double-suction, centrifugal pumps, directly connected to three 350-hp. Lentz 14½ and 24 by 27-in. tandem-compound steam engines, with normal speeds of 130 r.p.m. The units are placed diagonally, to economize space in the building itself and to bring the two 38-in. suction pipes of each pump close together in the suction bay. The engines are shown in Fig. 3.

One pipe is 16 ft. and the other 17 ft. long, and the intake end of one is one foot higher than the other. The pipes project straight down into the suction bay, which extends under the plant, and divides into three concrete chambers, one for each pump. The entrance to each chamber is protected by sets of removable iron racks to prevent coarse matter from getting into the pumps. The suction pipes are bell shape at the lower end, flaring to a diameter of 6 ft. to reduce entrance velocity and friction loss.

There are three discharge pipes with gradually increasing sectional area which are 128½ ft., 109 ft. 2 in. and 89 ft. 10 in. long, the difference in length being due to the position of the pumps. These pipes extend horizontally from the pumps to the crest of the levee and then to the concrete discharge bay in the river at an angle to the vertical of about 67 deg. The outlets are always under water and the pipes remain full or nearly so and the maximum benefit of the siphoning effect is obtained whether the pumps are running full capacity or not.

From the crest of the levee to the discharge end the pipes are not only buried in the earth, but are encased in concrete so that, although they may ultimately corrode away, it will never be necessary to renew them. The diameter of the pipes gradually increases from 54 in. at

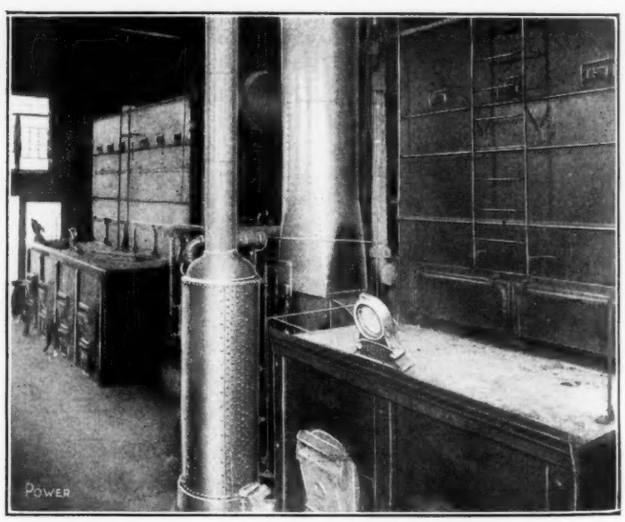

FIG. 2. BOILER EQUIPMENT AT THE LAZWELL PLANT

the pumps to 90 in. at the outlets, thus reducing the friction loss to the lowest value. The static head varies from zero to 14 ft., depending on the stage of the river, the average depth of which is 6 ft.

The Lentz type of engine was purchased because of its simplicity of construction and the high operating efficiency guarantee made by the manufacturer. (A description of the engine was published in POWER, Dec. 31, 1912.) These engines are equipped with speed-changing mechanism, adjusted by turning a handwheel at the end of the valve-cam shaft, while the engine is in operation, if desired. This feature is important because, with the centrifugal pumps, slight variations in the static head require speed adjustment for good economy. Steam at 150 lb. gage pressure and 125 deg. F. superheat is used. Super-

heaters are located in the first pass of the boilers. The piping is of extra-heavy weight with screwed flanges.

There are three vertical water-tube boilers, each of 210 hp. rated capacity. Dutch-oven furnaces and shaking grates, suitable for burning 1¼-in. Illinois bituminous screenings purchased on the B.t.u. basis are used. The screenings are delivered to the plant in wagons and stored on a concrete platform alongside the boiler room, and wheeled in for use after weighing in barrowfuls. Two of the boilers are shown in Fig. 2.

Induced draft is produced by a squirrel-cage fan, 54 in. in diameter and 30 in. wide, driven by a 5x7-in. vertical engine. Induced draft was selected because of the cost of building a foundation for a chimney to furnish natural draft, the subsoil being of such a nature as to require piling. A small vertical tubular boiler is employed for starting up, as with the induced-draft system it would be a difficult matter to raise steam readily in one of the larger boilers when cold, as well as arduous work to fill the boilers by hand.

There are two 7½x5x6-in., duplex, outside-end packed, plunger-type feed pumps. Feed water is drawn from the drainage ditch and fed without treatment to an open heater. A venturi meter in the discharge line of the feed pumps records the quantity of feed water supplied.

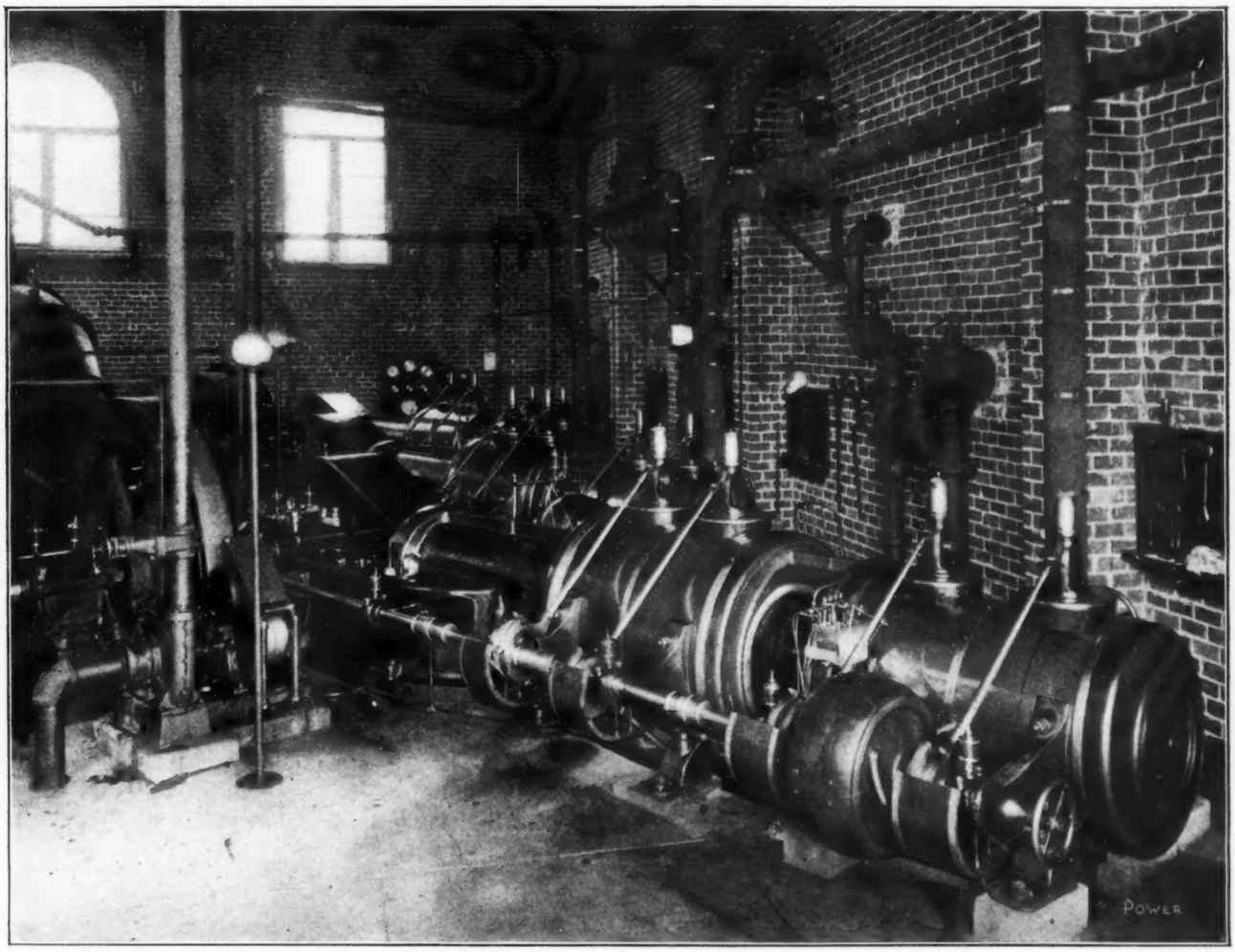

FIG. 3. LENTZ ENGINES DRIVING CENTRIFUGAL DRAINAGE PUMPS

Each engine exhausts to an 8-in. "Eductor" condenser mounted on the wall between the engine and the boiler room. Injection water, also drawn from the drainage ditch, is supplied by individual 4-in. centrifugal pumps, driven through friction pulleys from the flywheel of the engines.

A small high-speed, engine-driven, direct-current dynamo supplies current for the lights about the plant. The maximum overall coal consumption, when operating at full rated capacity against a 7-ft. static head, was guaranteed not to exceed 128 lb. of dry coal per million gal-

PRINCIPAL EQUIPMENT OF THE LAZWELL DRAINAGE-PUMPING PLANT

No.	Equipment	Type	Service	Size	Hp.	Speed	Steam lb.	Manufacturers
3	Engines	Lentz	Drainage pumps	14½x24x27″	350	130	150	Erie City Iron Works
3	Pumps	Centrifugal	Drainage	54″	...	130	...	Henry R. Worthington
3	Boilers	Water tube	Steam	.....	210	...	150	Erie City Iron Works
1	Fan	Squirrel cage	Draft	54″	...	...	...	Massachusetts Fan Co.
1	Engine	Vertical	Draft fan	5x7″	...	...	...	Troy Engine and Machine Co.
2	Pumps	Duplex	Boiler feed	7½x5x6″	...	...	...	Henry R. Worthington
1	Heater	Open	Feed water	.....	...	...	...	Erie City Iron Works
1	Meter	Venturi	Feed water	.....	...	...	...	Builders Iron Foundry
3	Condensers	Eductor	Engines	8″	...	...	...	Schutte-Koerting Co.
3	Superheaters	Foster	Boilers	.....	...	...	...	Power Specialty Co.

OPERATION DATA FOR MONTH OF 19 FOR PUMPING PLANT
HARMAN ENGINEERING CO.
PEORIA, ILLINOIS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
DATE	PRECIPITATION	DISCHARGE BAY	SUCTION BAY	STATIC HEAD	COAL BURNED	LB. WATER FED TO BOILER	STEAM PRESSURE	TEMPERATURE OF FEED WATER	R.P.M. UNIT NO. 1	R.P.M. UNIT NO. 2	R.P.M. UNIT NO. 3	PUMP HOURS UNIT NO. 1	PUMP HOURS UNIT NO. 2	PUMP HOURS UNIT NO. 3	TOTAL PUMP HOURS	WATER PUMPED AV. GAL. PER MIN.	WATER PUMPED IN ACRE FEET	COAL PER ACRE FT. PER FT. HEAD	GRAVITY PIPES HOURS OPENED	GRAVITY PIPES DISCHARGE IN ACRE FT.	STANDBY COAL	COAL PER ACRE FT. PER FOOT HEAD ON TOTAL COAL	ASHES	WOOD			

POWER.

FIG. 4. MONTHLY REPORT SHEET

lons of water pumped. The guarantee is based on the operation of all three pumps and two of the boilers so as to give the auxiliaries their normal load. The coal is also specified as Fulton or Peoria County, Illinois, fifth-vein bituminous screened lump, the proximate analysis of which is about as follows:

	Per cent.
Moisture	10
Volatile	36
Fixed carbon	42
Ash	12
Heat value	11,200 B.t.u.

METHOD OF OPERATION

The plant was designed and its operation is supervised by the Harman Engineering Co., Peoria, Ill. The coal contracts are made by this company and it systematically analyzes the coal delivered. The operating engineer at the plant submits a daily report, stating weather and working conditions; number and time of boilers in service; number and time of pumping units in operation and the revolution counter readings; water level in river and suction bay and the amount the level in the latter was lowered by the day's pumping; feed-water meter readings; weight of coal burned; labor employed, with description of work, hours and rate of pay; also, whatever other information that is pertinent, such as time of cleaning boilers, hot bearing developed, repairs made, etc. The engineer also sends in the charts from the recording steam gage and the recording thermometer for the feed-water temperature. From these reports the form shown in Fig. 4 is filled out, which gives the complete record of a month's operation.

The purpose of this system of supervision is to maintain the plant at its highest efficiency and so save all unnecessary expense.

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Temperature Tests on Journal Bearings

BY ALAN M. BENNETT

SYNOPSIS—Comparative tests showing the temperature rise with ball-seated bearings of different metals under both forced lubrication and ring feed. The results of a test on a concentric-sleeve bearing are also included.

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The curves here given are from the results of tests made by the writer for the purpose of determining the relative value of bearings of various designs and compositions, for high-speed duty, such as that met with in steam turbines, and their connected apparatus. It was decided that the tests should show, with temperature rise as a basis, the following specific comparisons:

First, that between bearings supplied with oil by ordinary ring feed and those in which forced lubrication was used; second, a comparison of results from the use of different materials under like conditions of lubrication, and, third, a comparison of the straight-seated and self-aligning types. In addition, from the last two series, was to be observed the effect on vibration of the various materials and methods of mounting.

The tests were made on journal-type bearings fitted to an ordinary direct-current motor, and all were run under the same conditions of load, bearing pressure and speed. In each case the run was continued until a constant temperature had been reached. The motor was run free, as it was thought that the resultant pressure on the bearings, due to the weight of the armature, load and varying tightness of belt would be difficult to accurately determine for each case. Besides, the condition of running free, so far as the bearings were concerned, more nearly approached that found in turbine sets, where the driving and driven machines are usually in line with each other, either coupled or on the same shaft.

The self-aligning bearings were all of the ordinary ball-seated type with one exception, that being composed of three concentric sleeves with oil clearances between them, the outer sleeve being doweled in the bracket, while the inner sleeves were free to rotate and accommodate themselves to irregularities of construction and alignment.

With the latter bearing, forced lubrication only was used, because of the difficulty of adapting it to ring feed. The oil was brought in at the top of the bearing through a $\frac{3}{8}$-in. pipe under a pressure of approximately $2\frac{1}{2}$ lb. per square inch. From the oil clearance between the outer sleeve and the one next to it, the oil was led by grooves and openings through the inner sleeves to the inner oil clearances and shaft. This method of bringing in the oil also obtained with the rest of the bearings in which forced feed was used. The ring feed was effected by means of two rings.

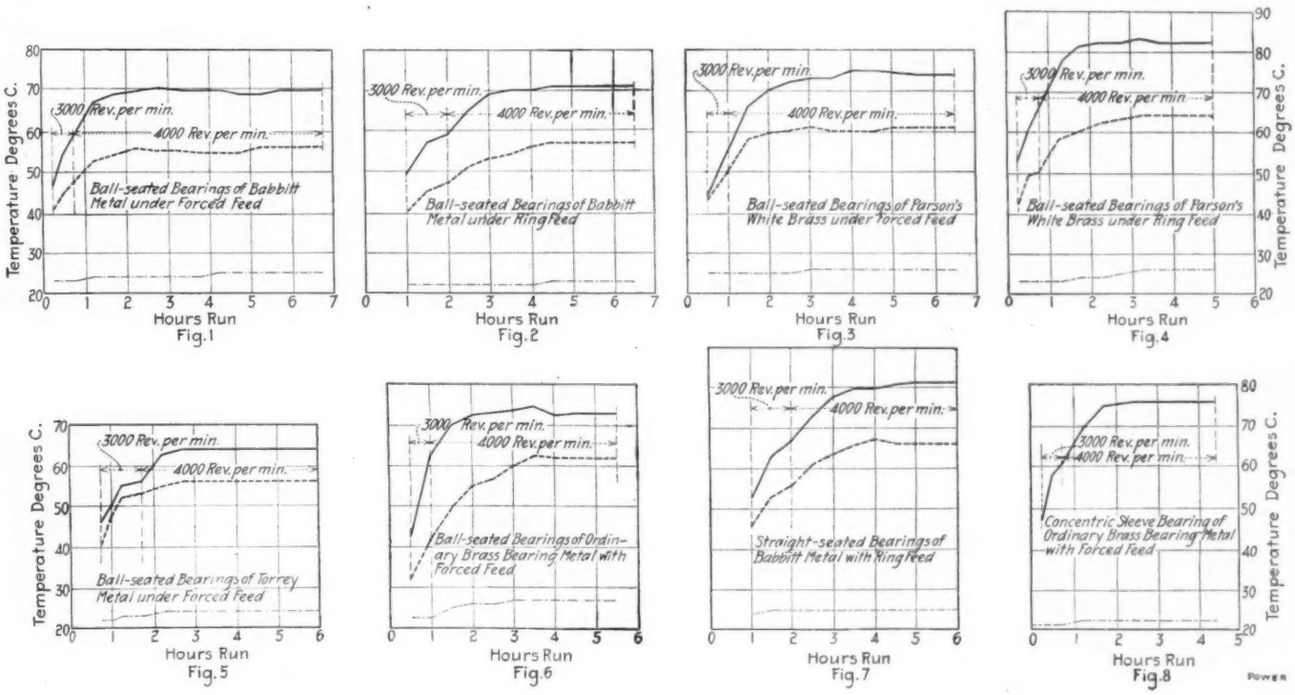
All the various bearings were of like size, having a nominal bore of $1\frac{3}{4}$ in., and a length of $5\frac{1}{4}$ in. The actual bore of the bearings was between 0.0025 and 0.003

in. larger than the journal diameter. The pressure per square inch of projected area on the front and back bearings was 23 and 28 lb. respectively.

A close estimate of the heating effect on a bearing can be obtained from the rubbing coefficient, or the product of the peripheral speed of the journal in feet per minute and the pressure per square inch of projected area. With a value for this coefficient of approximately 40,000, the bearings will show a temperature rise of 35 to 40 deg. C. the conditions of oil supply being favorable. At the foregoing pressures, and a speed of 4000 r.p.m. at which these tests were run, the values of the rubbing coefficient for the front and the back bearings

The curve in Fig. 8, for the concentric-sleeve bearing, is plotted from an average of two runs on the same bearing. So far as temperature rise is concerned, this does not offer any advantage over the bearings of ordinary construction, the temperature rise being practically as high as that of some of the other bearings with ring feed. With this bearing, however, the vibration of the machine was very perceptibly lessened, and it is probable that the increase in temperature can be accounted for by this fact, the vibration being absorbed in the bearing and manifested in heat.

With the straight-seated bearings, Fig. 7, the vibration was much more noticeable than with any of the self-


Temperature Degrees C.
Hours Run
Fig.1
3000 Rev. per min.
4000 Rev. per min.
Ball-seated Bearings of Babbitt Metal under Forced Feed
Fig.2
Ball-seated Bearings of Babbitt Metal under Ring Feed
Fig.3
Ball-seated Bearings of Parson's White Brass under Forced Feed
Fig.4
Ball-seated Bearings of Parson's White Brass under Ring Feed
Fig.5
Ball-seated Bearings of Torrey Metal under Forced Feed
Fig.6
Ball-seated Bearings of Ordinary Brass Bearing Metal with Forced Feed
Fig.7
Straight-seated Bearings of Babbitt Metal with Ring Feed
Fig.8
Concentric Sleeve Bearing of Ordinary Brass Bearing Metal with Forced Feed
POWER

TEMPERATURE RISE PLOTTED AGAINST TIME OF RUNNING

respectively were 42,000 and 51,000. From this it will be seen that, even though the motor was running light, the bearings were well loaded.

COMPARISON OF RESULTS

The tests in Figs. 1 to 4 inclusive show that a forced oil supply at the pressure given has an advantage over ring feed in keeping down the temperature, the bearings under the former running cooler by an average of nearly 10 per cent. than those with the latter. This gain in temperature decrease, however, is offset by the added complication and expenses of providing means for pumping the oil through the bearings. To this must be added the possibility of breakdown and failure of the pump, a contingency not to be reckoned with when ring feed is used. Inspection of Figs. 1, 3, 5 and 6, which were run under forced feed, shows a difference of temperature rise in favor of the softer metals. The tests in Figs. 2 and 4, in which ring feed was used, also show this same result.

Between the ball-seated and straight-seated bearings, the choice lies with the former. In Figs. 2 and 7, which show a comparison of these types, there is a difference of 8 deg., or 16 per cent., in the case of the back bearings, and 7 deg., or 20 per cent., between the front bearings.

aligning bearings. Of the latter, the babbitt-metal bearings appeared to have a greater effect in reducing vibration than those of the harder metals.

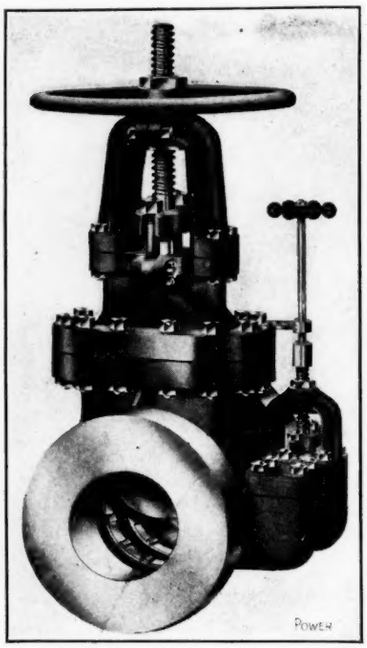
Improved Victor Gate Valve

This valve can be had made entirely of brass or iron body, brass mounted, in "puddled" semi-steel and also cast steel. The valve is made in two forms: one with stationary stem, and the other with outside screw and yoke. The seat rings, also the wedge disk, can be renewed when worn. That portion of the valve body which receives the seat rings is threaded to the correct angle of the tapers of the valve disk. The valve seats are removable. As the valves are double seated, they will take pressure from either end.

Either pattern of valves can be packed under pressure when wide open. The stuffing-box in the valve with stationary stem is screwed into the hub. The gland and stuffing-box are lined with bronze bushings, which forms a bearing surface for the stems. The disks are accurately guided in the bodies, and the guides relieve the stems of side strains, which have a tendency to wear out the

threads. The stems in both forms of valves are made of rolled tobin bronze.

The joint between the body and hub consists of grooves cut in the top surface of the valve body, in which are placed seamless copper gaskets. The valve can also be had with exterior bypass, a view of which is herewith shown. The bypass is cast integral with the body. The additional metal required for the bypass strengthens the



LUNKENHEIMER GATE VALVE WITH BYPASS

valve body; being self-contained, it is not affected by extremes of expansion and contraction. The bypass-valve trimmings are bolted to the valve body. The stuffing-box is made of bronze and has a flange on the bottom thereof, which prevents the iron flange above it from touching the iron body, and, hence, prevents corrosion between these surfaces.

The bushing, which is threaded to receive the threads on the stem, not only prevents corrosion, but also makes it possible to renew the same when worn. The area of the bypass is sufficiently large to admit enough steam around the disk to quickly equalize the pressure on both sides.

The Lunkenheimer Co., Cincinnati, Ohio, is the manufacturer of this valve.

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Hydraulic "Hydro-Cator" Indicator

The "Hydro-Cator," a new hydraulic indicator, is shown herewith. It is designed to indicate the depth of water or other liquids in tanks of all kinds, reservoirs, water towers, wells, sumps, filtering plants, etc., and can be located any distance above, below or from the liquid to be indicated.

The device is manufactured by the Sterling Gauge Co., 134 East Larned St., Detroit, Mich.

This instrument is simple in construction, free from moving parts, and always shows the exact amount of water in the tanks or water towers, in inches, feet or gallons.

The contents of the tank is indicated by a brilliant-red liquid or by mercury in a glass tube. The scale reading is 10 in. high for the standard instrument, which represents the full depth of the tank, whether it is 2 ft. or 100 ft., as each gage is specially calibrated for the depth of tank and specific gravity of the liquid to be indicated. They are made with glasses, up to 72-in. readings if desired.

The instrument, Fig. 1, is fastened to the wall of an office, etc., and an ⅛-in. outside diameter capillary copper tube, annealed, and very flexible, is run to the tank either above or below the ground; it contains only air and will not freeze or stop up. One end of this hollow tube is attached to the top of a casting, 6 in. in diameter, called the compressor, Fig. 2, and is attached to the bottom and outside of the tank, or it may be lowered from the top of the tanks to the bottom on the inside.

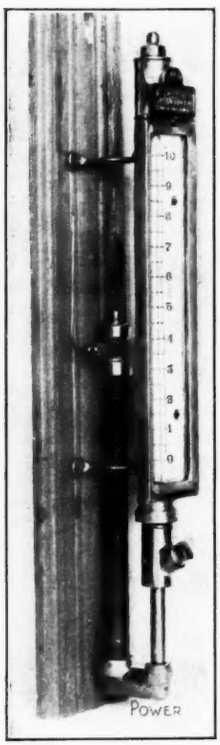

FIG. 1. HYDRO-CATOR

Static pressure of the liquid in the tank forces the trapped air in the compressor and tube line against the indicating liquid in the instrument, and causes it to rise in the glass tube in proportion to the height of liquid in the tank. It is not necessary to empty a tank of its contents when installing the apparatus. It is charged with air at any time by attaching a standard bicycle-tire pump to the cap on the top of the instrument and a few strokes of the pump will put the instrument in balance with the liquid in the reservoir. The "Hydro-Cator" will then show the depth of water in the standpipe or tank.

It serves as well to indicate the rise and fall of water

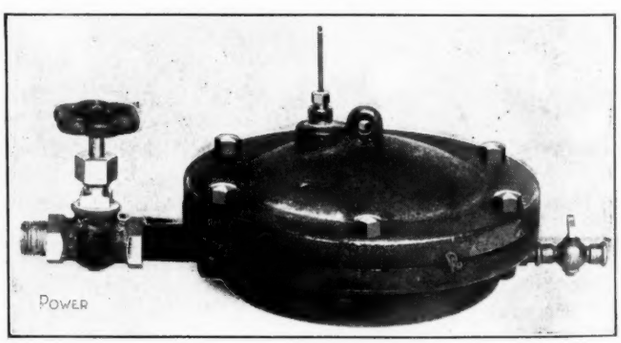

FIG. 2. COMPRESSOR

in rivers, dams and flumes and can be used for registering oils, gasoline, syrups, spirits and chemicals. It is not affected by any variation of temperature.

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Fine grinding can be done with a coarse-grain wheel under the proper conditions; in the same way a fine wheel may produce rough work. Many of the scratches which appear on ground work are made by small particles of metal between the wheel and the work. Good grinding demands conditions which allow these particles to escape.—"American Machinist."

Inaccuracies of Indicators*

By James G. Stewart

SYNOPSIS—The indicator is subject to systematic errors not generally recognized. For important deductions from indicator diagrams the instrument should be calibrated for those errors. Results of experiments and description of special apparatus employed for determination of errors of indicators.

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[Some experiments to determine the errors to which an indicator is subject are described in the original paper, and for the purpose of presenting concrete conception of the errors both of mean pressure and shape of the diagrams the author gives a correction of the diagram of Prof. Burstall's "Crosby-Hopkinson Comparison Tests," a paper read before the Institution of Mechanical Engineers in 1909, these having been chosen because the indicating was considered of the highest order with the given instruments. Mr. Stewart's research was carried out in the mechanical-engineering department of the University of Birmingham and experimenting upon the identical indicators used in Prof. Burstall's comparison tests.—Editor.]

A consideration of the uses to which some of the most eminent engineers have put the indicator and of the far-reaching deductions made by them led to this investigation of its behavior. Professors Callendar and Nicolson, in their classic experiments on the temperatures in the steam engine, found a discrepancy between the temperature of the steam as measured directly and as calculated from the indicator diagram. The discrepancy, although small, they explained by a theory of instability of state of steam during expansion; it could be explained very satisfactorily by an error in their indicated pressures if such could be proved to exist. Professor Burstall in his gas-engine work has made much use of the indicator; he has calculated from its diagrams the temperatures of the gases throughout the expansion stroke and compared them with actual measurements of these temperatures. He has enunciated a law of cooling in the gas-engine cylinder, and supported it by the agreement of deductions made from it with the indicated form of the expansion line. Dugald Clerk, in his well known work on the specific heat of gases, has depended almost entirely on his indicator diagrams.

Prof. Bertram Hopkinson has also used his indicator to determine the specific heats of gases, and has found unexplained peculiarities toward the end of compression and beginning of expansion. The problem of the behavior of gases in a gas-engine cylinder would be much simplified if these could be explained by errors in the indicator.

In steam-engine work an almost absolute reliance is placed on the indicator diagram; from it one deduces dryness fractions of the expanding steam and draws the corresponding entropy diagrams; from which, in turn, various deductions are made of heat interchanges taking place in the cylinder. In the measurement of indicated horsepower there is not more reason for putting trust in the indicator. If through any cause a large amount of friction were offered to the motion of the pencil, the indicated horsepower would be much in excess of the true horsepower for diagrams of the usual shape.

The author's experiments lead to the conclusion that the errors in indicator diagrams are much greater than has been usually assumed. They show that there is a lag, often very great, of the pencil behind its true position, and that the error so introduced is not a constant but generally increases with the stiffness of the spring and with the pressure. These errors, large, yet not readily apparent, are not uniform but vary with different indicators and even with different springs of the same scale. Such errors and the uncertainty of their magnitude are hurtful to the progress of engineering. The indicator should either be an accurate instrument, or a ready means of measuring its errors should be devised. The methods used in the author's experiments help to make the latter alternative possible, and the results, insofar as they point out the causes of errors, will be useful to designers in their search after the former.

There is in the indicator the possibility of two distinct errors:

(1) The indicated pressure may not be that corresponding to the pressure in the cylinder, due either to friction or to inertia of the moving parts or to both.

(2) The position of the drum may not be that corresponding to the position of the piston, due to stretch of the string or to straining in other parts of the indicator gear. These will be considered separately.

In the author's experiments, Crosby gas-engine indicators, internal-spring type, fitted with heavy pattern pencil gear, were used. As the only essential difference between the Crosby gas-engine indicator and the Crosby steam-engine indicator is the diameter of the piston, the results are applicable to the steam indicator, bearing in mind that the scale of the springs must be altered in proportion.

As indicator diagrams are subject to error from many causes which are really defects of the engine and not of the indicator, it is necessary, in order to determine the errors of the indicator, to eliminate errors of the former class. In the pencil motion a chief source of error in steam-engine work is the presence of water in the indicator or in its connection with the cylinder; this has been avoided by using compressed air as a working fluid. In the drum motion, errors of design of the indicator gear were eliminated by a differential method. Further, as no satisfactory deductions on pencil motion could be made from a diagram taken from an engine, a special method was used.

Motion of the Pencil (or of the Equivalent Pressure Indicating Mechanism of the Optical Indicator)—To record the pressure accurately the pencil must have for each pressure a single definite position, and it must take this position whenever the pressure in the cylinder is that corresponding to the position. This is only approximated to in any indicator. Friction and the inertia of the moving parts introduce errors; there may also be an error due to slackness in the pins of the pencil gear, which error, however, is one which ought to be avoided. A knowledge

*Extracts from a paper entitled "Indicators," presented at the January meeting of the Institution of Mechanical Engineers, London, England.

of the friction and the inertia gives the data necessary to calculate the error in the motion of the pencil.

Frictional Resistance to the Motion of the Pencil—If a Crosby indicator be subjected to pressures represented by the line *abcd,* Fig. 1, it will be unable to follow the instantaneous change of pressure represented by *bc,* and in consequence oscillations will be set up, and the pencil will give some such indication as *abefghd,* Fig. 1. These os-

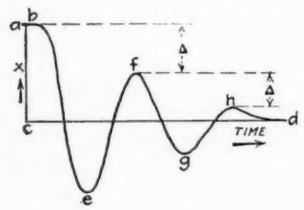


FIG. 1

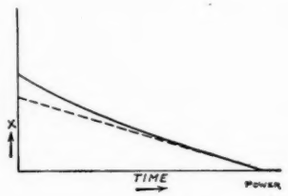


FIG. 2

OSCILLATIONS DUE TO FRICTION, AND THEIR AVERAGE EFFECT

cillations will gradually die out, and experiment shows that the damping per oscillation (Δ) for each of the oscillations is very nearly constant, Fig. 1. It is slightly greater when the oscillations are large, but for general purposes this variation may be neglected. This condition of constant damping per oscillation is an indication of the nature of the friction which is damping the motion, namely, that it is "solid" friction, that is, it is of constant amount and always opposed to the motion; further, the frictional force is equivalent to $\frac{\Delta}{4}$ lb. per in.^{2} on the piston. As the successive maximum heights of the pencil above its true position can be measured and plotted, Δ can be obtained with considerable accuracy from the slope

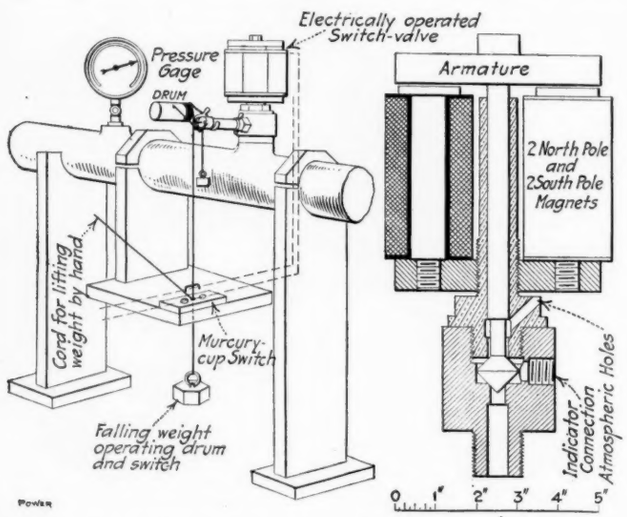


FIG. 3. INDICATOR-TESTING APPARATUS AND SECTION OF SWITCH VALVE

of the mean curve, Fig. 2. The slope at the point at which the curve cuts the time axis gives the true solid friction. Increased slope at other points indicates the addition of a small amount of fluid damping, as shown, Fig. 2.

Experiments to Determine the Resistance to Motion of Pencil—In these the apparatus shown in Fig. 3 was used. An ordinary high-pressure air bottle had two bosses welded on; one carried a pressure gage, the other a valve of special construction. The indicator was attached to the special valve shown. This valve was double-seated. When the valve was on the lower seat, the indicator was open to the atmosphere; when it was on the upper seat the indicator was open to the bottle, which in working conditions held air under pressure. This valve was operated by a magnet which made possible a very rapid switching over of the valve, and therefore subjected the indicator to a very rapid change of pressure. This sudden change is an approximation to the instantaneous change represented by the line *bc* in Fig. 1. The drum was actuated by a falling weight; the weight in falling pulled in the fork of a mercury-cup switch, thus closing the magnet circuit and switching the indicator from the pressure air to the atmosphere. By properly timing this switch the valve could be made to act at a suitable time, and a record of the movement of the pencil was obtained on the diagram. The pressure of the pencil on the paper

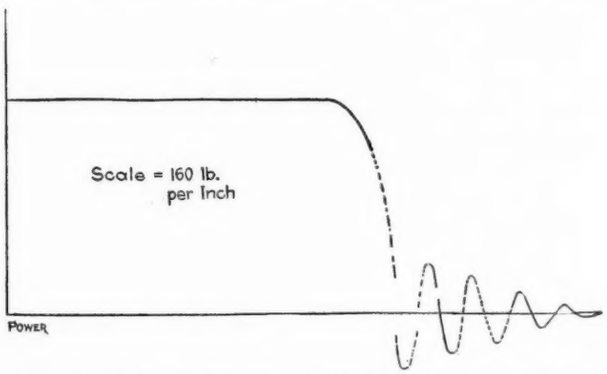


FIG. 4. FACSIMILE OF A DIAGRAM OBTAINED FROM TESTING APPARATUS

was adjusted by the screw provided, and the screw was held against the stop by hanging a small weight to it. Fig. 4 is a facsimile of an actual diagram obtained from this apparatus. It was originally intended that the switch-valve should give a practically instantaneous change of pressure in the indicator cylinder. This, however, was found impossible, but fortunately the very satisfactory oscillation diagrams obtained were sufficient in themselves to give complete information.

The frictional damping forces were calculated in terms of their equivalent pressures on the piston of the indicator; they were found to vary with change of conditions. So far pencil pressure is the only recognized variable, but other and much more serious causes of variation were found. It was only after much work that these variables were separated. Variation of the friction may be stated to be due to variation in:

(1) The pressure of the pencil on the paper.
(2) The stiffness of the spring.
(3) Different springs of equal stiffness.
(4) The pressure of the working fluid in the indicator cylinder.
(5) Different indicators.

The irregularity of the behavior of indicators is very unsatisfactory; it means that in any accurate work, indicator diagrams cannot be accepted unless accompanied by a statement of the peculiar behavior of the indicator used in taking them. With regard to past work it would be necessary, if its results are to be accepted, that the experi-

menter should get back to his original indicator and supplement his work by a statement of its errors. That error which varies with the pressure and which is due to restraining couples is the most troublesome; its presence can only be detected by some such method as that used in these experiments. The difficulty of detecting even its presence is no reason for believing it to be small. It is probably not too much to say that the indicated horsepower is frequently 10 per cent. or more greater than the true value. Dr. W. E. Fisher has called the author's attention to an engine test which shows the presence of errors of this magnitude. With diagrams of the ordinary form the effect of friction is to increase the diagram, and when this friction increases with the pressure the increase in the size of the diagram will be greater for higher initial and back pressures in the cylinder. This effect Dr. Fisher obtained by working a Willans engine: (1) condensing, (2) noncondensing; maintaining throughout the same brake horsepower. He used selected indicators and found an increase of indicated horsepower between the two cases of 3 per cent. using Crosby indicators and an increase of 4.6 per cent. using McInnes Dobbie indicators. The McInnes Dobbie indicators throughout gave much larger indicated horsepowers than the Crosby indicators; between the indicated horsepower (condensing) as obtained by the Crosby indicators and the indicated horsepower (noncondensing) as obtained by the McInnes Dobbie indicator there is as great a difference as 10 per cent. If to this be added the percentage error in the Crosby we obtain the result that the indicated horsepower as obtained by the McInnes Dobbie indicator is greater than the true horsepower by more than 10 per cent. In this experiment the assumption is made that the mechanical efficiency of the engine is constant when the brake horsepower is maintained constant, an assumption which there is much reason to believe is true or very nearly so.

It has been assumed that the friction, as measured from the oscillation diagrams, is the same as that in the indicator when the motion is that of the ordinary indicator diagram. This requires justification. It has already been pointed out in the analysis of the oscillation diagram that the friction is practically independent of the velocity; consequently its magnitude is equally great even when drawing a constant-pressure line. It is generally believed that the vibration of an engine is sufficient to relieve the indicator of all solid friction. To determine whether this was true, an indicator was fitted to a Belliss high-speed engine and a weak spring was put in the indicator. The drum was rotated by the indicator gear. The indicator cock was open to atmosphere throughout. The indicator pencil was deflected first above and then below the atmospheric line as in the Reynolds static friction test. On releasing it gently, it took a final position which even after many revolutions was almost as far distant from the atmospheric line as it would have been if it had not been subject to any vibration. With heavier springs the possibility of relieving friction by vibration is still less. The motion of the piston and pencil gear may cause additional vibration. But such was present in the oscillation experiments and its effect is, therefore, included in the friction as obtained from them. The same result was obtained on the Premier gas engine. The particular Hopkinson indicator which was tested showed errors much greater than the Crosby.

In experiments made to determine the periodic times of oscillation of the pencil, the drum of the indicator was insulated and a spark made to pass at timed intervals from the pencil point through the paper to the drum, piercing in its passage a hole in the paper. The pencil was set in oscillation and the drum rotated as in the friction experiments.

[The calculated values were found so near the experimental that for most practical cases it would appear to be sufficient to take them as accurate. Other sources of error in pressure indicating referred to in the paper are the better-known errors due to friction and which are ordinarily guarded against by careful experimenters. Among these errors the writer includes those due to: (1) Water in the connections, (2) insufficient size of connections increasing errors due to presence of water, (3) inaccurate calibration of springs, variable strength of springs depended upon for uniformity of scale and calibration at temperatures different from temperatures at which they are used, (4) slackness in the joints of the pencil gear, and (5) inaccuracies in measuring the area of the diagrams. The latter half of the paper is devoted mainly to discussion of inaccuracies of the drum motion. Error in the drum motion when flexible wire was used was found to be small and the author suggests that the error would have been very small if a stiffer and less elastic wire had been used in the straight parts of the length of the drive. Some experiments were made with short springs in the length of the driving wire. The errors in the motion were, of course, large, but there was nothing in the appearance of any one set of diagrams without comparing them with another set which would enable one to detect the presence of oscillations or errors of any kind. Referring to indicators generally the author concludes as below.—EDITOR.]

The design of no indicator recognizes sufficiently the necessity to insure only simple axial forces throughout the whole range of motion of the indicator piston. As workmanship can never be accepted as absolutely accurate, the design must be such that small inaccuracies in workmanship do not introduce large constraining forces and consequent large errors. Generally this will be secured by leaving the system as free as possible and in particular by arranging that no unnecessary restraint is put upon the spring or the piston. On high-speed engines the optical indicator must be used, the inertia of the drum and pencil levers being too great; even if diagrams can be taken, that is no proof of their accuracy; in fact, and more particularly with regard to absence of oscillations of the pencil, the more imperfect indicators will give the smoothest and apparently best diagrams.

Largest Turbo-Generator

The Commonwealth Edison Co., of Chicago, is soon to have the largest turbo-generator in the world. This will be a G. E. turbine of horizontal type and will be rated at 30,000 kw. It will generate three-phase, 25-cycle current, at 9000 volts and will run at 1500 r.p.m.

This will be installed in the station with the 26,000-kw. Parsons machine which the company ordered from England some time ago.

Touching upon the economies effected by the United States Steel Corporation, Mr. Farrell, its president, said that blast furnaces at Gary run 92 gas engines, which save 3,500,000 tons of coal per annum.

Steam-Loop and Gravity-Return System

By J. C. Hawkins

SYNOPSIS—An 800-hp. plant is equipped with a steam loop and gravity-return system. No traps are used in returning the condensation to the feed-water heater. The system has been in operation three years and gives excellent results.

❖

While the theory of the steam loop may be understood, its direct application in handling condensation from high-pressure steam lines is not so well known. Herewith are illustrations showing the piping of a steam plant in which the steam loop has taken care of the condensation with good results for about three years.

The plant is of about 800 hp. capacity and has four boilers, five engines and seven pumps of various sizes. The only interruption to the service was due to replacing a split coupling and repairing a leak in a pipe.

Principle of Operation

The principle of operation of the steam loop and gravity return is simple. If a closed vessel or tank is placed above the boiler and connected to it by two pipes, one to the water and the other to the steam space, the pressure in the vessel will be the same as that in the boiler and the water in the pipe will stand at the same level as that in the boiler. If the valve on the vent pipe of the closed vessel is opened, the pressure will be lowered and water will rise in the one pipe to such a height that the added weight counterbalances the difference in pressure between the boiler and the tank, and steam will flow through the other pipe into the vessel in its effort to equalize the pressure. If the steam rising to the closed vessel holds water in suspension, the water will be swept along with the steam and discharged into the chamber where it falls to the bottom and flows into the pipe connected to the water space, thus increasing the head of water in the return line.

As the extra head of water overbalances the increase in its height, due to the difference in pressure between the boiler and the closed vessel, the water will flow into the boiler until the water in the pipe reaches its former level. This action causes the slugs of water and steam to rise from the receiver to the discharge tank, and, to further aid the system, a check valve is placed near the boiler in the return line which prevents the water from rising in the return line of the other side of the system should it be closed for any reason.

Piping Layout

In the system under discussion connections are all made to the bottom of the steam line where water can collect and the condensation is piped to a receiver below the lowest po'nt of the line. Also a ¾-in. equalizing steam line is connected to the receiver from the header.

From the bottom of the receiver, through a 1½-in. pipe, in which long-radius bends are used in place of fittings, the water and steam rise in slugs to the discharge chamber. Entering the top of this chamber they separate, the water falling to the bottom and running to the return line. A ¾-in. vent pipe from the top of the chamber connects to the exhaust pipe through a regulating valve, and a telltale is placed in a position to be easily seen by the engineer.

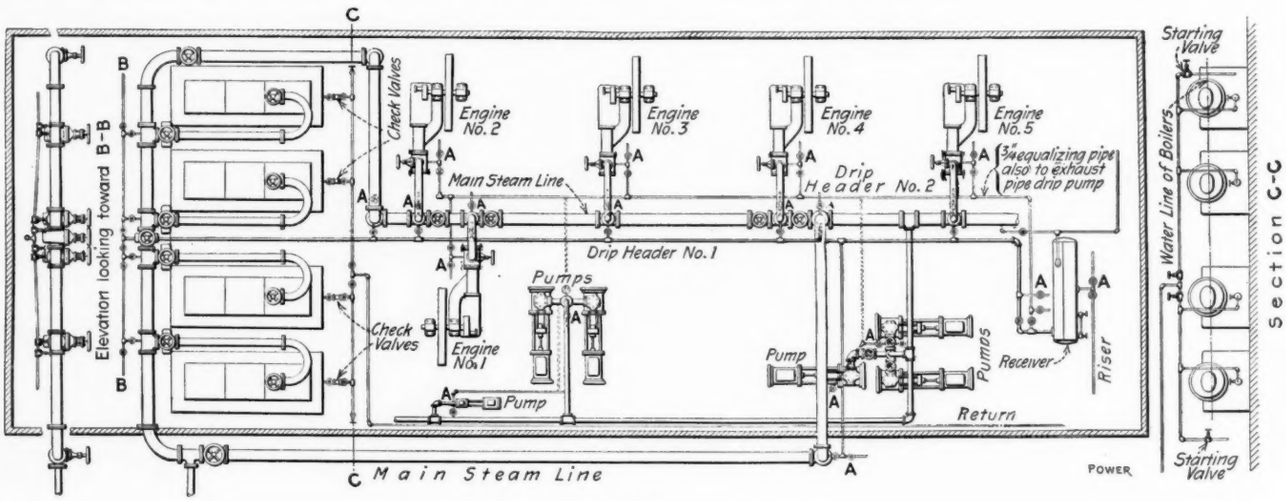


Fig. 1. Plan View of Piping

The vent pipe is to decrease the pressure in the discharge chamber as well as take out any air or noncondensible vapors that collect in the upper tank. As the exhaust is used for heating, any steam blowing through the regulating valve is not wasted. The vent pipe is not covered and any steam condensed in the pipe, by its weight, tends to lower the pressure in the discharge tank.

If the return were shut off or became stopped up, the discharge chamber would fill and water would come over in the vent pipe and be seen blowing from the telltale cock.

As shown in Fig. 1, a plan of the piping giving the location of the boilers, engines, etc., the main steam line forms a loop around the boilers and some of the engines, with gate valves, are so placed that in the event of a failure of any part of the line such part can be cut out without shutting down the whole plant, which is run 24 hr. per day. The steam line is set level and cross fittings

are used instead of tees for the branches, to the bottom of which the drip lines are connected.

Boiler Piping

The boilers are connected to the 9-in. steam line by 9x9x6-in. tees with a gate valve next to each tee and the usual long-sweep bends with an angle valve at the boiler. From the bottoms of these tees a 1-in. pipe runs to the drip header No. 1; this connection is shown in detail in section *BB*.

Valves near each connection and each side of the drip header, allow any part of the system to be cut out in case of accident to the main. A ½-in. bleeder, or "open blow" as it is called, will drain the steam from that section when repairs are necessary. On the main steam line, in the engine room, 9x9x7x7-in. crosses are used to take off the branches to the engines. To the bottom of

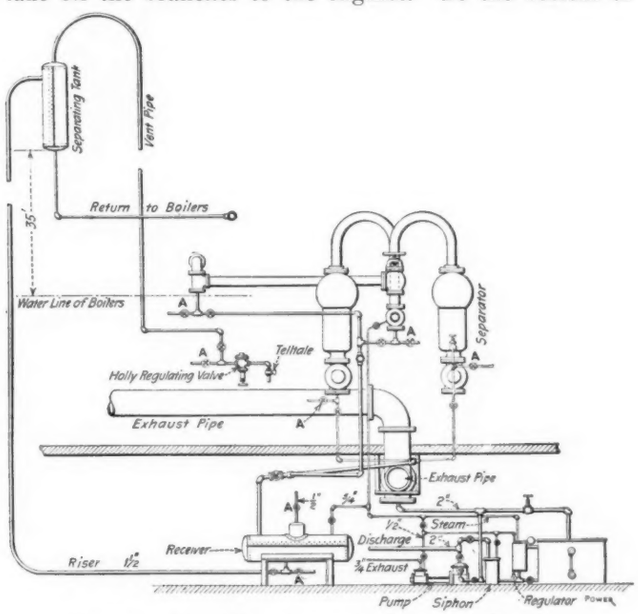


Fig. 2. End Elevation of Piping Layout

each a ¾-in. drain is connected to the header No. 1, which is placed about 1 ft. below and 4 ft. to one side of the steam main, and is hung on posts which divide the room into two bays.

Each connection is made with a nipple tee, nipple and valve with an open blow, located at all connections, as shown at the points *A*; the connections are shown more in detail in Fig. 2.

The drain from the separators, which is a 1-in. pipe above the floor, and those from the pump connections, are carried down below the floor to header No. 2, because they are lower than No. 1 header; this arrangement also brings the drips out of the way of an open blow that is placed at each connection and a valve in the line to each separator for the reasons already stated. Header No. 2 is in a trench beside the exhaust pipe.

The receiver is in a pit below the floor and the headers are connected thereto with valves for cutting out and draining either branch. This is shown in Fig. 2, which is the end view of the piping. A ½-in. vent on the top of the receiver is for blowing out air in starting, or to release the pressure for starting. A 1½-in. pipe runs from the bottom of the receiver to the discharge chamber, which is placed 35 ft. above the water line of the boilers.

The reason for locating the discharge chamber at a height of 35 ft. or over is not only to prevent siphonage, but to give a better working head. The modern tendency is to increase the height of the discharge chamber for economy in the use of steam piping. Reducing the diameter of the pipe frequently produces pressure losses which are altogether out of proportion to the small economy effected by the use of small pipe, so that the discharge losses are sometimes even higher than 10 lb. To have a safe margin of altitude, the balancing point should be preferably about half way up the return leg. It will require 25 ft. of vertical head above the boiler water line to balance, and from 5 to 8 ft. more to open the check valves and overcome frictional resistance, so that 35 ft. to the bottom of the receiver is the safe minimum and 10 ft. or 20 ft. more is taken if possible. A lower height than 35 ft. would work, if the loss in pressure between the boiler and discharge chamber is correspondingly less than 10 lb., but it is not safe.

No fittings are used in the riser, all turns being made by bending the pipe to reduce friction. The discharge chamber and pipes connecting to it are in a pipe stack and out of the way. The return pipe leads to the bottom of the tank and passes from the pipe stack near the ceiling of the engine room to the back of the boilers where it branches off and connection is made to each boiler below the water line, with a swing check valve and two gate valves in each connecting pipe. The main return and branches are all 1½-in. pipe. Section *CC* shows the return piping more fully, also the starting valves on each end of the return line, near the boilers. One starting valve is necessary, but two are placed so that with one side of the return out of commission the other can be used; this also brings the valves out of the way.

Starting the System

To start the system, all the branches into the headers are opened with the bleeders closed. Then the vent valve on the receiver is opened until all of the air is blown out of the inlet side. Then the bleeder is closed, the valve in the riser opened and one of the starting valves opened and allowed to blow until dry steam shows. Next the vent valves, the telltale and the Holly valve, as it is called, are opened; the system will then be in full operation and so continue, as long as there is steam in the pipes, without further attention. The regulating valve in the vent pipe is opened a very little and the steam escaping through it reduces the pressure in the discharge chamber, which is further reduced by the siphoning action of the water condensed in the vent pipe, but as this goes into the feed-water heater it is not lost.

The telltale, or ¼-in. pet-cock, is partly closed and blows steam into the air where it can be seen and heard. It will also blow water if the return to the boiler is closed; if the riser is closed, either steam or water will blow as long as the system is working.

In cutting a boiler in or out of service, the valves on the return line to the boiler are operated at the same time as the main stop valve, unless it is desired to use all of the condensation in one boiler. In that case all the return lines are cut out except the one to receive the returns.

Gate valves are used in this system, but if globe valves were used they should be placed with the stem in a horizontal position. Gate valves are preferable to reduce

friction. A swing check valve near the connection to each boiler prevents the water surging from one to the other, and water from the boilers backing up into the discharge tank and into the steam line. All pipes, tanks, etc., are covered except the vent pipes.

Advantages and Disadvantages

The disadvantages of this system are long lines of pipe and the height at which the discharge chamber must be located, but these are offset by a system of drainage for the high-pressure lines that is always in working order and demands no attention. It has no moving parts, requires little steam, returns the water to the boilers at a very high temperature and, if properly installed, will last as long as the steam line. The steam main may be tapped wherever there is a water pocket, thus insuring dry steam without the danger of a sudden dose of water in the engine cylinder.

The cost of operation and the results obtained are so satisfactory that after years of experience with all kinds of pumps, traps, etc., the writer regards this system as the most dependable and reliable as well as economical means of dealing with condensation in the high-pressure lines in buildings that will admit of placing the separating tank at the required height.

The exhaust line, which is below the floor, is a little different from that usually seen. A 3x4x6-ft. tank, in the sub-basement below the exhaust pipe, is connected to it by a 2-in. pipe. This tank is drained by a 2½ and 5 by 5-in. single-cylinder pump, and by a siphon in a closed chamber, which is used in case of repairs to the pump. A regulator is so connected to the tank that the height of the water in the tank controls the steam to the pump or siphon through a float and valve, thereby taking care of the exhaust condensation without loss of steam.

The pump or siphon can be run independently of the tank or regulator. This is done at present, as this pump is used as a wet-vacuum pump and, with the heating system, carries a vacuum of from 1 to 8 in.

The exhaust-pipe drip pump and connections are shown in Fig. 2. On account of the slight difference in level of the exhaust pipe, a sewer pump or trap was necsary, and of the two the pump was found the most reliable. Drips are also pumped through an oil separator, then into the feed-water heater and saved. The pump has been in constant operation over two years and has been packed only once during that time; so far it has not been found necessary to use the siphon except to try it out.

Machinery Exhibits at Panama-Pacific Exposition

Rapid progress is being made in the construction of the main exhibit buildings at the Panama-Pacific International Exposition at San Francisco. The first of the buildings is now completed and five other structures are under way There will be fourteen main exhibit buildings in all, and contracts will be let upon the others to bring all to completion by July, 1914. Work upon the Machinery Building, the largest of the group, is advancing and the framing of the main portion of the structure is partly completed. This will permit the complete installation of exhibits by the opening date, Feb. 20, 1915. The exposition management plans a record not only in construction but in the presentation of a finished spectacle on the opening day.

The department of machinery exhibits is thoroughly organized and filings for exhibit space have been received to an extent that assures a fine display. Early applications are especially welcomed by the management and will facilitate the proper grouping of the exhibits and the perfection of other arrangements essential to the interests of exhibitors as well as to the exposition.

For the information of exhibitors the following brief data have been forwarded by the exposition company: The Machinery Building will have nearly eight acres of floor space. In addition, there will be an auxiliary structure to be known as the Gas and Fuels Building. The electrical machinery will be located in the Machinery Building and classed under the general heading of machinery.

All parts of the building will be served by adequate crane facilities. Alternating and direct electric current, gas and water will be available in any portion of the building; compressed air and steam will be provided in a section adjacent to the Gas and Fuels Building. General illumination is to be provided by the exposition company, but a nominal charge will be made to exhibitors for other utilities service they desire. Special rates for power will be made to exhibitors who use it to show machinery in motion.

The Machinery Building floor is designed for 200 lb. per sq.ft. The soil conditions will permit adequate foundations for heavy machinery to be readily constructed. No charge will be made for exhibit space.

The management urges that concerns and individuals desiring to participate lose no time in getting into touch with the company and filing applications for space.

Copies of the rules and regulations, the classification of exhibits, blank applications for space, and other information prepared for the guidance of exhibitors will be promptly forwarded on request to the Panama-Pacific International Exposition Co., San Francisco, Calif.

Bristol Revolution Counter

The revolution counter, made by the Bristol Co., Waterbury, Conn., is designed for use wherever mechanical movement is to be counted. It is made of iron and steel, according to the metal best suited to its purpose. The dials are white, with ½-in. figures in black.

The principal feature of this counter is that all the figures can be set back to zero with one turn of a key. The counter, according to size, registers, 10,000, 100,000 and 1,000,000. The casing is of polished brass.

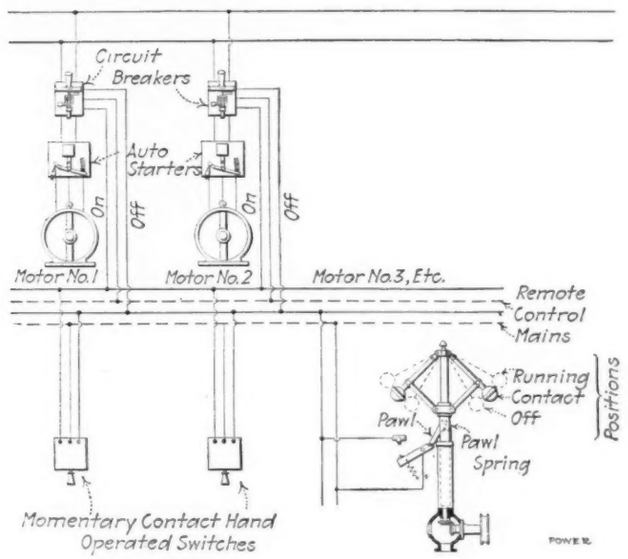
Heating a building by means of steam pipes embedded in the concrete floor has been successfully accomplished in the chassis testing building of the Moline Automobile Co., Moline, Ill. The structure is 120 ft. long by 60 ft. wide with door openings extending completely across the ends of the building. The workmen are obliged frequently to lie on the floor in making necessary repairs and adjustments and on this account, it was desired to keep the floor surface comfortably warm. To accomplish this, 1¼-in. steam pipes spaced 42 in. on centers were laid 2 in. below the surface of the 6-in. floor slab. The concrete is reinforced locally against crackling due to the expansion of the steam pipes by corrugated, galvanized iron pipes enclosing the former. Below the floor slab, 8 in. of cinder fill is placed as an insulating material. It is stated that with only five small metal radiators additional, it is possible to obtain a uniform temperature of 65 to 70 deg. Fahr. throughout the building.—"Contract Record."

ELECTRICAL DEPARTMENT

Electric Control for Conveyor Belts

By D. R. Shearer

Not long ago the writer was called upon to design an automatic control system for six interdependent conveyor belts. The conditions to be met were such that at first it seemed difficult to achieve a satisfactory result, but finally a system was developed which promises to be satisfactory in every particular.



Control Circuits Connected with Governor

Four of the belts are arranged so that each dumps onto the succeeding one, thus forming a continuous conveyor line. The other two are used alternately, both being fed by the main belt-conveyor line. The control requirements were as follows:

Should any belt stop through failure of driving power, breaking of the driving belt, overloading or clogging, the others should also stop, thus preventing the accumulation of load on the motionless belt. It was necessary also that all the belts be arranged to stop or start from any one of several points. Of course, it was necessary that the unused belt of the alternate pair should have no effect upon the operation of the remaining five.

The control system as finally designed is shown in the sketch. All the belts are motor-driven, and each drives, through a sprocket and chain from a friction roller, a special governor of the flyball type. This governor is so arranged that at a critical speed, about two-thirds the running speed, an electrical contact is closed; as the speed falls still lower the control circuit is opened, so that when the belt and governor are at rest, there is no electrical contact

Moreover, this contact is closed only as the governor slows to the critical speed and not as it is coming up to speed past this critical position; the pawl in this case slips by the switch. Thus, in starting the belts from rest to full speed no contact is made, but should any one, or all, the belts slow down to a certain speed, or stop, the control is closed.

Each driving motor is furnished with an auto-starter, and also with a remote-control circuit-breaker. These circuit-breakers not only act as switches for the remote control, but also have overload and no-voltage release mechanisms. The relay current, or current used to operate the circuit-breaker solenoids, is taken from the main feeders, but has separate fuses. For starting and stopping an instantaneous contact, three-point hand switch is used, so that relay current may be thrown on either the make or break solenoid of the circuit-breakers. The governor, however, is connected only to the solenoid which trips the breaker.

It is evident from the foregoing that should any operating belt slow down or stop, its governor will close the contact, and trip not only its own circuit-breaker, but all the others. After the cause of the stopping has been removed all the breakers may be thrown in from any of the hand switches. Should it become necessary to stop all the belts by hand, this can also be done by throwing the hand switches to the other point.

Water Rheostats

By R. L. Daugherty

In some recent testing it was necessary to construct a water rheostat to absorb the power from a 2200-volt, three-phase, 150-kw. generator. It was also desired to overload the generator up to about 210 kw., which meant a maximum current of about 60 amp. per phase. On account of the high voltage, ordinary water was sufficient and the rheostat was suspended in a creek running alongside the power house.

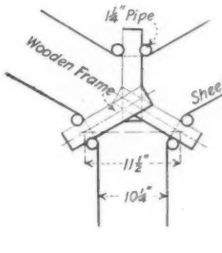


Fig. 1. Plan of Rheostat

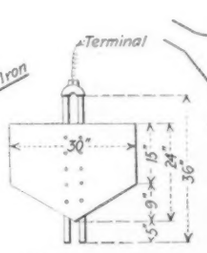


Fig. 2. Sheet before Being Bent

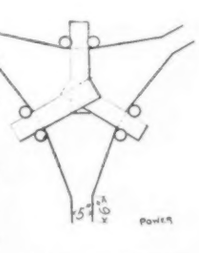


Fig. 3. Rheostat after Alteration

There was little information to be had upon rheostats of this type, so the first one built was in the nature of an experiment. For each of the three terminals, two pieces of 1¼-in. pipe, 3 ft. long, were screwed into a return bend with a back outlet. In the back outlet was placed a pipe plug with a hole drilled for the wire, which was held by a setscrew. These pipes were suspended from a wooden frame and each pair was placed at the vertex

of an equilateral triangle having 15-in. legs. It was found upon test that when the pipes were immersed 6 in., 10 amp. per phase was absorbed. When immersed 24 in., only 22 amp. per phase was absorbed, giving a total power consumption of about 80 kw. As 2 ft. was the greatest depth of immersion that could be obtained at a convenient spot, the rheostat had to be rebuilt.

This time the pipes were placed a little closer together, the leg of the triangle being reduced to 11½ in. (See Fig. 1.) In addition, a piece of No. 24 sheet iron of dimensions shown in Fig. 2 was bolted onto each pair of pipes, holes being drilled in the latter for that purpose. This sheet was then bent back to form an angle of 120 deg. so that each adjacent pair of sheets were parallel.

FIG. 4. RHEOSTAT SET UP IN CREEK

The point of the sheet was put 5 in. above the end of the pipes so that a light load could be easily obtained.

When the rheostat was immersed 2 ft., as before, 52 amp. per phase was absorbed. As this was not sufficient the plates were bent to bring them closer together, as in Fig. 3. A current of 60 amp. per phase could then be obtained with a 16-in. immersion.

The framework supporting the pipes was suspended from a tripod set up in the creek, as shown in Fig. 4.

For testing a 110-volt, direct-current machine of 30 kw. capacity, it was desired to construct a rheostat which would offer enough resistance to consume 60 amp. or less and which could also consume as much as 300 amp. It was decided to use iron wire as a resistance and keep it cool by immersing it in the creek.

This was impossible to calculate with any exactness because no one could tell what the temperature and hence the resistance of the wire might be under the conditions. Two light wooden frames were made that were 3 ft. long and 11 in. square. One of these was wound with 60 turns of No. 10 and the other with 60 turns of No. 14 galvanized-iron wire. That made 220 ft. of each size. It was found that these two frames in series offered more than enough resistance for our purpose. This resistance was reduced by tapping in at different points until fairly large values of current were reached. The two frames were then placed in parallel and then the two were cut down simultaneously. The heaviest current carried was 240 amp. and for that we had 59 ft. of No. 10 in parallel with 77 ft. of No. 14. The expected 300 amp. was not obtained because the waterwheel being tested was not able to run the generator at its rated capacity.

Care and Operation of Commutators

The article by H. S. Page, in the May 20 issue, is very instructive to the average operating engineer or electrician. The writer has charge of a number of machines, two of which are compound-wound, 8-pole, 200 kw., 600-volt, direct-current generators running at 220 r.p.m. The two units are duplicates and are used for street railway service, the load fluctuating from 0 to 150 per cent.

The commutators are 30 in. in diameter with a 6-in. face and are fitted with eight brush-holders of the box type, two brushes per holder. We were first troubled with squeaking chattering brushes and the commutators were frequently lubricated with engine oil or vaseline, but this gave us trouble by destroying the mica between the segments at the outer edge of the commutator.

We tried several grades and makes of carbon brushes but they would soon begin to chatter and spark and burn the commutator. After setting the brushes in oil for a time they would do nicely for a few days after which the same trouble would begin again.

The brush-holder and brush adjustments were gone over time and again with no improvement. We tried slotting the commutators and this helped for a while but at intervals the troubles would occur without any apparent cause. We then tried a good grade of graphite brushes and this did away with the chattering and squeaking but after they were in use for some time they would get very hot and particles of the brush would adhere to the holders and cause them to stick and spark badly. The brush would not touch the commutator but this could scarcely be detected by the eye. By going over the brushes and commutators again the troubles would disappear for some time. Later we installed a motor-generator set to operate between the direct-current and alternating-current systems so that either system would help out the other.

Next we tried alternate sets of carbon and graphite brushes. This made the positive brushes graphite and the negative carbon or *vice versa,* then the graphite brushes would get hot and stick and spark. We then placed one carbon and one graphite brush in each holder with the graphite brushes in the positive holders on the outside, but this part of the commutator soon became so badly burned that it required frequent turning. We, therefore, put the carbon brushes in the positive holders on the outside but the inner part of the commutator would burn away and require turning the commutator.

We discontinued slotting the commutator but this did not help, so we then placed two graphite brushes, one positive and one negative, on the outside and carbon brushes inside, and in the next two holders carbon brushes on the outside and graphite inside and so on around the commutator. Since placing them this way we have had very little trouble.

C. E. NYE.

Morgantown, W. Va.

GAS POWER DEPARTMENT

Cylinder Heads of Horizontal Single-Acting Motors*

By Max H. Müller

At the beginning of stationary-motor development a great variety of cylinder-head patterns prevailed, but a very simple form is now gaining ground. Both theory and practice teach that simple, compact forms are useful because they favor rapidity and completeness of combustion. The Güldner design has been of great influence in this respect, and its type of simple coherent combustion chamber with central ignition has been carried from the vertical to the horizontal engine.

In the gas engine there must be a quick passage of the flame from the place of ignition through the combustion chamber, the charge having been already prepared by mixture and compression; while in the oil engine there must be a rapid impregnation of all the air with the sprayed fuel. On one hand, a very small compression chamber is necessary in order to attain the required degree of compression, while on the other, there must be provided valve ports corresponding with a high piston speed. Also, in spite of these openings, the inner combustion chamber must be made strong enough, and the cylinder head elastic enough to follow without fracture the distorting forces that act on it between combustion chamber and cooling jacket.

Since these imposed conditions are in part conflicting, a compromise is necessary. It would be preferable, from the viewpoint of cheapness in manufacture, to have a form of cylinder head which, as in the case of the vertical motors, best exemplified in the Güldner, could be used not only with the ordinary liquid and gaseous fuels, but also with heavy oils as in the Diesel or constant-pressure process.

Of late, the Augsburg-Nürnberg Co., in Germany, has taken the lead in introducing a form of combustion chamber similar to that shown by Fig. 1, except in the design of the flanges. According to the form of attachment, which varies in different factories, it consists of studs which are either screwed into the connecting flange of the frame and hold the flange of the cylinder head, Fig. 2, or *vice versa*, or are screwed into the flange of the frame and pass through the whole length of the cylinder head, Fig. 3. These various methods of attachment are of differing worth and indirectly they are probably to blame for many cracks in cylinder heads of horizontal oil motors.

Aside from cracks of characteristic form and position that result from cooling strains of the metal in casting, may be distinguished all those which occur in the inner combustion chamber or in the cooling jacket. The former are generally due to insufficient thickness of the wall of the combustion chamber or to irregular distribution of the material by displacement of the core. In part, such cracks are also attributable to insufficient stiffness of the front head, which may be distorted when subjected to the high pressures. This refers primarily to those designs in which the back wall of the cooling jacket is formed by a cover bolted on (Fig. 4) and where consequently the springing cylinder head is unsupported by the cooling jacket.

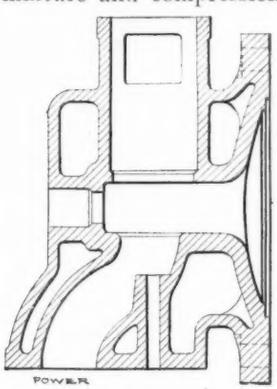


Fig. 1

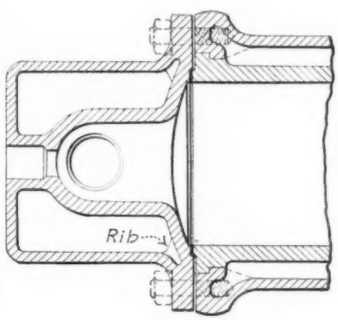


Fig. 2

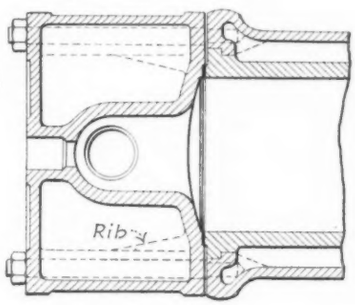


Fig. 3

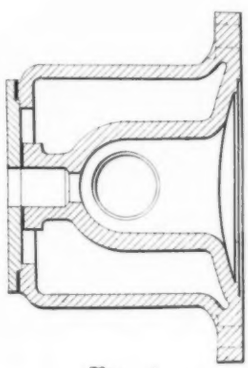


Fig. 4

In order to resist such effects, which sooner or later, either by accidental strains or by fatigue of the material, must lead to fractures of the inner combustion chamber, it is important to make the front wall so strong that, even when the core is displaced, the weakest part will withstand breakage. Also, it should be sufficiently rigid so that the elastic flexures undergone at every impulse, will be as small as possible; these results to be accomplished without depending upon the cooling jacket to sustain the tensile forces and without greatly affecting the cooling operation by inordinate thickness of the cylinder-head wall. This requirement is best filled by supporting ribs which connect the outer part of the head with the cooling jacket. See Figs. 1, 2 and 3.

Besides the formation of such cracks in the inner combustion chamber, attributable to defective material or to faulty stiffness of the head, cracks very often are found in the seats of exhaust valves. This happens more fre-

*Translated from "Der Oelmotor.

quently in gas engines than in oil engines, due very often to neglected and corroded valves and seats which have been working with dirty producer gas.

It is very essential that there be a uniform distribution of material about the exhaust-valve seat and also the greatest possible effect of the cooling water on the seat from the outside. The latter point requires that the walls shall not be too thick and further, in large engines, that there shall be a maximum withdrawal of heat from the exhaust-valve cone by a well cooled valve-stem guide bushing, or for large cylinder heads, by an independently cooled exhaust valve.

More numerous and harder to avoid than defects of the inner combustion chamber, are cracks in the water jacket, especially of constant-pressure horizontal engines. Undoubtedly the cracks are generally caused by expansion of the combustion chamber. The heat of combustion which strikes the inner chamber of the cylinder head at each impulse, expands it, while the water-jacket temperature remains comparatively low and the combustion chamber tends to distort the water jacket at the place where it is attached. Thus tensile and bending stresses and transverse forces arise in the outer jacket and lead to cracks, and the properties of cast iron are very ill suited to sustaining such stresses. Moreover, strains of unknown magnitude and form remain in the casting from the foundry.

Therefore, to prevent subsequent cracking in service, by relieving the casting strains, it is necessary that cylinder heads of horizontal motors should be annealed, as has long been the practice with vertical ones.

Of transcendent influence, however, is the question of design. This must, at the start, eliminate all connections between combustion chamber and cooling jacket that are not absolutely indispensable. Furthermore, the lever arm of flexure—the distance between the jacket and the combustion chamber—should be as great as possible in order that the change of form may be a minimum. Care must also be taken that the joint flange contains no large masses of material and is as thoroughly cooled as possible.

This last point is often neglected, but it is easy to perceive that if the thick, and only slightly cooled, joint flange expands under the higher temperature more than the jacket to which it is connected, it must loosen and crack at the joint, as is evidenced by the fact that cracks of the jacket almost always occur close along the flange. At this place the axial effects of the external forces and of the inner tensions, with the radial stresses at the flange, are, to a certain extent, accumulated to form very considerable main stresses. It is also important to avoid abrupt transitions between the jacket and flange and further to provide a minimum distance between packing surfaces and the bolt circle.

This last condition is usually hard to meet simultaneously with the others, since the packing surface must naturally be as near as possible to the combustion chamber in order that the load on the studs shall not be too heavy. This, however, for a large jacket diameter, necessitates an increased distance from the bolt circle, which, when using thick flange bolts, results in an inordinate stress on the jacket when they are screwed up hard.

If all conditions are to be complied with as well as possible, then, after the pattern of vertical motors, the jacket should be increased to the flange diameter and the strong studs should pass through the inside of it, as in Fig. 3. This expedient has the advantage that the jacket can be held together very firmly by the tension of the studs.

Cylinder heads of this form, while retaining the well proved conaxial position of inlet and outlet valves, have lately been employed on horizontal Diesel motors of the Erfurter Maschinenfabrik Franz Beyer & Co., of Erfurt, Germany, and it may be assumed that this design, which had already been tried on small Deutz gas engines, will also be justified for horizontal Diesel motors.

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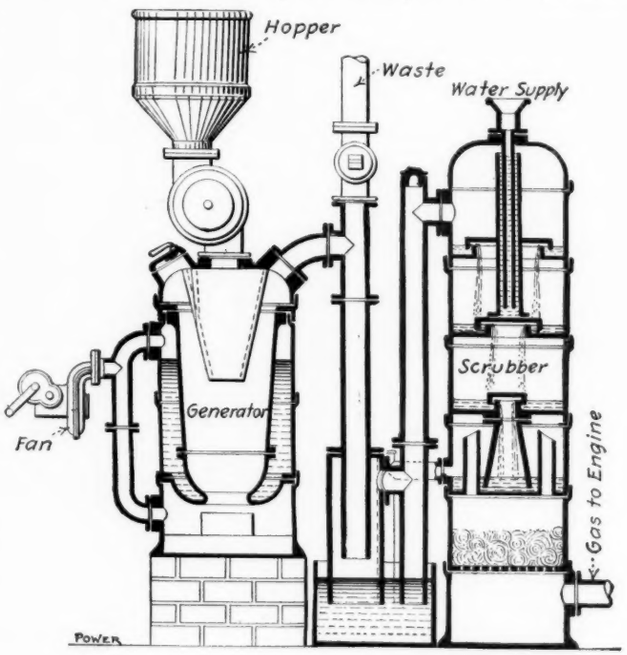
The Warwill Producer

By James A. Seager

With the usual suction-gas plant in which a firebrick lining is used, trouble frequently arises in connection with the lining, and the efforts of the manufacturers have been to make the lining as homogeneous as possible.



Section through Producer and Scrubber

Moreover, after running the producer for some hours, the lining, in direct contact with the fire, is apt to become partly fused and form clinker, decreasing the gas-making area and preventing the plant from working at its full capacity. Hence a type of generator which does not depend upon a firebrick lining deserves attention. This is not new and untried, but has stood rigorous tests both as regards efficiency and life. Such a producer is built by the Warwill Engineering Works of Abertillery, Eng., and, although employing the same principles as adopted in most gas plants, embodies some unusual features of construction, which are illustrated in Fig. 1.

The furnace lining is of cast iron, entirely surrounded by a water jacket, which also forms the vaporizer. This, besides serving to supply the necessary steam, also keeps the temperature of the lining sufficiently low to prevent the adhesion of clinker. Moreover, since the lining is of cast iron, and is always kept at a comparatively low temperature, it does not burn away, thus minimizing repairs

and renewals. A further point of importance is that air leaks are practically eliminated.

In order to secure so far as possible continuous working, even in the smallest sizes of plants, the makers employ a movable cage into which all clinker gravitates and is removed through the door of the generator. This has the effect that the fire is always kept clean and bright; an essential feature in plants that are required to run continuously for long periods.

Reference to the illustration shows that some radical differences exist between this type and some of the more common forms as regards the scrubber. In the ordinary coke-packed scrubber there is a tendency for the interstices to become filled with foreign matter, such as grit, dust, particles of tar, etc., and the coke has to be renewed at frequent intervals, often involving stoppage of the plant. Moreover, about 60 per cent. of the volume of the scrubber is taken up by the coke itself, the remainder, less than one-half the total capacity, being available as gas space. The resistance offered by the coke-packed scrubber is never uniform, but is continually increasing, owing to the accumulation of dirt and dust on the surface of the coke. Frequently, owing to the presence of free ammonia and sulphur compounds, the odors arising from coke scrubbers have been found objectionable.

The scrubber is arranged in a series of water seals, kept in constant agitation by the suction of the engine, and in this way the impurities taken from the gas are not allowed to deposit in the scrubber, but are washed from each division into the one immediately below it, until eventually by means of the overflow they leave the scrubber.

The plant throughout is made of a special mixture of cast iron, the uncombined carbon of which is found to resist corrosion much better than the combined carbon of mild steel. Both the scrubber and generator are built in short sections, and occupy very little ground space.

Up to the present the average life of the Warwill plant has not been determined. Whether the makers can furnish any information on this point remains to be seen, but it is stated that there are plants working today which were erected the latter part of 1907, and have not needed extensive repairs or renewals.

Cleaning Blast-Furnace Gas*

By Fred H. Wagner

With practically the same character of apparatus—first, dry-dust cleaners; second, some sort of static towers like the Czchokke or Steinhardt, and, finally, the Theisen washer, the cost of the final cleaning varies between 15 and 62c. per 100,000 cu.ft. of blast-furnace gas cleaned, this being based on $10 per 1,000,000 gal. of water and one cent per kilowatt-hour. Why such discrepancies should exist is difficult to explain. For instance, at one of the corporation plants, the final cleaning, based on 100,000 cu.ft. of gas costs 61c., at another 47c., a third 25c., at another 20c. and at still another 15c.

Mr. Sampson mentioned that some new apparatus, which is along the line of mechanical disintegrators, claimed to use about 20 gal. of water per 100,000 cu.ft. of gas, for the whole cleaning process, and to operate on less power than the Theisen washers He also stated that with the present process from 90 to 100 gal. are used for the entire cleaning process. Besides the Theisen washer mentioned by Mr. Sampson, there are two others, which are attracting a great deal of attention in Europe in connection with this process, namely, the Schwarz washer and the Feld washer. These both require less power than the Theisen washer, but the Feld requires considerably less power than the Schwarz.

At the blast furnaces in Donawitz, where 1,600,000 cu.ft. of gas is treated per hour, the total power with the Schwarz washers amounts to from 124 to 128 hp. At the blast furnaces in Pompey, France, of the same capacity, the Feld washers use from 50 to 55 hp.; this power includes that necessary for the exhausters.

Each section of the Feld washer contains a series of perforated truncated cones, the lower ends dipping into the water, and by the revolving of these cones, giving a peripheral speed of 1600 ft. per min., the water is carried up inside the cones and hurled out of the perforations in a finely divided spray.

In the blast-furnace plant at Pompey, France, where the Feld washers are also in use for cleaning blast-furnace gas for gas-engine purposes, prior to the use of the Feld washers, it was necessary to open the valve chests on the engines about once every ten days and remove the accumulated dust; since the installation of the Feld system, it has only become necessary to open the valve chests about once every three months. These washers have been in continuous operation for about 30 months without a shutdown for cleaning or repairs—the washers being self-cleaning, the water carrying the dust, leaves the washer in the form of thin mud, which is easily handled by centrifugal pumps.

*Discussion of Mr. Sampson's paper on "Operating Gas Engines Using Blast-Furnace Gas," which was presented at the spring meeting of the A. S. M. E. and printed in abstract in last week's issue.

Gas-Engine Piston Troubles

Recently the writer was called in to examine a gas engine of the horizontal type, which the operator said was trying to knock its cylinder head out. It was found when opening up the cylinder that the rings were kept in place by an ordinary junk ring held by eight 7/8-in. studs, one of which had dropped out, and had been pounded to pieces. This had driven one of the other studs into the junk plate, splitting it and breaking out a large piece.

As this engine ran a small mill, it was necessary to have it running at the earliest moment. We obtained a spare junk ring from the makers, which had to have all the holes plugged and fresh ones drilled. When it came to putting the junk back, it was found that all the studs were loose in the piston head, and as one could not be obtained locally, as a last resort they were dipped into thick boiled oil, which kept them tight until the arrival of a new set, when, judging from the trouble in removing, they would have lasted much longer.

From observations on a number of gas-engine pistons fitted with junk plates, the writer has found a tendency for the screws to work loose, which, after all, is not to be wondered at when the great changes in temperature are taken into account. This refers to noncooled pistons.

E. Russell Pearce.

Rochdale, England.

HEATING AND VENTILATION

Rates and Regulations for Central-Station Hot-Water Heating

In its controversy with the Toledo Railway & Light Co., the public service commission of Ohio has issued an important decision prescribing rules for determining the amount of radiation required, rates for service, and the specifications to be met in such service. The new schedule issued by the commission is to go into effect Sept. 15, 1913, and should have its influence on the central-station heating industry in the state.

For determining the square feet of radiation required to heat a building, the following rule is to be used: Determine the area of the exposed walls in the building. From this subtract the area of windows and door openings (frame measurements). This remainder should be divided by the wall constant given in Table 1, and to the result should be added the area of window and door openings (frame measurements). This sum should be

TABLE I. WALL CONSTANTS

For 1-in. wall	1
For 2-in. wall	2
For 4-in. wall	3
For 6-to 9-in. wall	5
For 9-to 10-in. wall	7
For 13-to 27-in. wall	8

TABLE 2. TEMPERATURE CONSTANTS

For 65 deg. F.	0.0075
For 70 deg. F.	0.0082
For 75 deg. F.	0.009

multiplied by 75, and to this result should be added the cubic contents of the room. Multiplying the sum last obtained by the temperature constant given in Table 2, will give the square feet of cast-iron radiation required to heat a building of good construction. Any room or space having an opening which may communicate with the rooms to be heated must be included in the measurement for space heated, whether radiation be installed or not.

The rule is for ideal conditions and to the radiation requirement determined by its use, there must be added a percentage to provide for exposed locations, bad construction, insufficient or improper repairs and other conditions which would make the minimum radiation requirement inadequate to keep the building comfortably warm. For these conditions which cannot be ascertained by general rule add from 5 to 25 per cent. to the minimum for ideal conditions.

It is specified that the heating company must furnish hot water in sufficient quantity to heat the building to a temperature of 70 deg. F. in the coldest weather, provided that sufficient radiation be installed by the consumer to maintain the desired temperature. Evidence of the sufficiency of the quantity of water shall be that the temperature of the hot water has not dropped more than 30 deg. F. while passing through the consumer's heating system, as shown by not less than four tests taken 15 min. apart in succession, the tests to be made at the point of entrance of service to the building.

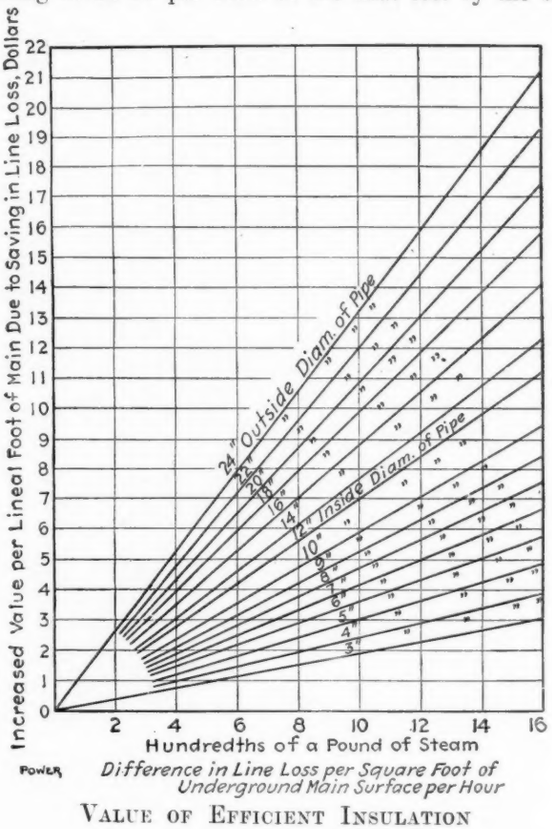
Surface area of all hot-water pipes installed in the basement or elsewhere not included in the measurement for radiation will be charged for as radiation, unless covered with at least 1-in. covering. The following rates were ordered to be put into effect:

Amount of Radiation Installed	Cost of Radiation per Season, per Sq.Ft.
0 to 500	$0.20
500 to 2000	0.1888
2000 to 5000	0.1777
5000 or over	0.1666

For indirect radiation 40 per cent. of the above rates are to be added.

Efficiency of Underground Steam Mains

In a paper read before the annual meeting of the Engineering Society of the American District Steam Co., Byron T. Gifford defined the efficiency of a pipe covering as the percentage of heat saved by using the covering. For example, 90 per cent. efficiency would mean that the covering saved 90 per cent. of the heat lost by the bare



VALUE OF EFFICIENT INSULATION

pipe. The line loss in underground steam mains varies from 0.4 lb. or less of steam per square foot of pipe surface per hour in the most efficient construction to 0.14 lb. or more per square foot of surface with insulation of inferior quality.

To show the advantage of more efficient covering, the author took a concrete case with the following assump-

tions: Square feet of surface in the mains and services, 13,423; capacity in pounds of steam per hour, 30,000; average selling rate per thousand pounds of steam, 55c.; hours in heating season from Oct. 1 to June 1, 5832.

The accompanying table gives the pounds of steam required per season for the system outlined above, with insulation of different qualities covering the piping:

Insulation	Pounds Steam per Season	Line Loss in Dollars
No. 1 Line loss at 0.04 =	3,131,316	$939
No. 2 Line loss at 0.05 =	3,914,147	1173
No. 3 Line loss at 0.06 =	4,696,874	1409
No. 4 Line loss at 0.07 =	5,479,806	1644
No. 5 Line loss at 0.08 =	6,262,632	1879
No. 6 Line loss at 0.09 =	7,045,463	2113
No. 7 Line loss at 0.10 =	7,828,294	2348
No. 8 Line loss at 0.11 =	8,611,021	2583
No. 9 Line loss at 0.12 =	9,393,748	2818
No. 10 Line loss at 0.13 =	10,176,680	3053
No. 11 Line loss at 0.14 =	10,959,612	3288

The line loss in dollars given in this table was computed on a basis of 30c. per 1000 lb. as the generating cost of the steam. From these data it is easy to compare the saving of one insulation over the other, for example, by using No. 1 instead of No. 8 a saving in line loss of $1644 will be effected.

It is generally recognized that a good pipe line will last about 20 years, so that for depreciation 3½ per cent. (sinking fund) of the investment would be charged. Allowing 5 per cent. for interest it is plain that a fixed charge of 8½ per cent. on the investment must be paid every year. To calculate the amount it would be advisable to spend for efficient covering the fixed charges (interest and depreciation) on the additional investment should be compared with the decreased income due to greater line loss. By using No. 1 instead of No. 8, the insulation will save $1644 per year. This is 8½ per cent. of $19,341.20 and anyone would be justified in paying this additional sum for the 13,423 sq.ft. of underground pipe surface, that is, No. 1 insulation on the piping is worth $19,341 more than No. 8 insulation.

Under these conditions the eventual saving per square foot of surface is

$$\frac{\$19,341}{13,423} = \$1.44 \text{ per sq.ft.}$$

The line loss for No. 1 insulation is 0.04 lb. steam per square foot per hour, the line loss for No. 8 is 0.11, making a difference in line loss of 0.07 lb. of steam per square foot per hour. For each 0.01 lb. of steam it is then possible to save per square foot of surface per hour, $144 ÷ 7 = 20.6c. Calling this figure 21, it is not difficult to properly classify and value different styles of insulation.

Take, for example, 1000 ft. of 8-in. line. To compare two insulations, one with a line loss of 0.05 lb. per hr, and one with a line loss of 0.14 lb. per hr., the difference being 0.09 lb., the following expression may be used:

$$n \times s \times L \times 21c.$$

where

n = Hundredths of pounds of steam lost per square foot;

s = Surface of the pipe per lineal foot;

L = Length of line;

21c. = Constant based on 30c. per 1000 lb. of steam, 5832 hr. per season.

Substituting in this formula the values in the above example gives:

$$9 \times 2.25 \times 1000 \times 21 = \$4252.50$$

This shows that $4.25 per lineal foot of 8-in. line is the increased value of the more efficient insulation. The accompanying chart, which shows the value of efficient insulation on pipes of different diameters, was based upon this formula. As an example in the use of the chart, take a 12-in. pipe line when the difference in efficiency is 0.08 lb. of steam per hour. Find 8 on the horizontal scale and follow this line up to the 12-in. line, then follow horizontally to the left and find that the difference in value is $5.61 per lineal foot.

Coal Required for Heating

In the issue of Apr. 15, W. L. Durand gave a preferred rule for estimating the amount of coal required during the heating season, and also made some objections to three rules used in New York City for the same purpose. Mr. Durand showed that for pea coal of 12,000 B.t.u., 78.75, or practically 80, lb. per sq.ft. of radiating surface per season would be required. The three rules to which he objected were as follows:

1. *Grate area multiplied by 4.4 equals tons of coal burned per season.*

2. *Each cubic foot of contents will require 0.9 lb. of coal per heating season.*

3. $$\frac{\frac{\text{Exposed wall surface}}{4.5} + 2 \times \text{glass surface}}{100} = \text{tons of coal per heating season}$$

Some interesting data bearing on these rules have been submitted by the engineer of a large department store in Chicago. The building has a contents of 18,000,000 cu.ft., a wall surface, exclusive of glass, of 240,000 sq.ft., a roof area of 99,000 sq.ft., and a glass surface of 240,000 sq.ft. The building is heated entirely by live steam, and is equipped with 160,000 sq.ft. of radiation, which to the volume bears a ratio of 1 to 112.5.

Rule 2 allows 0.9 lb. of coal per cubic foot. Thus, $0.9 \times 18,000,000 = 16,200,000$ *lb.* $= 8100$ *short tons.* Averaging the five years 1908 to 1912, inclusive, the actual coal consumed was 7250 tons. It should be mentioned, however, that about one-sixth of the volume given above is in the basement and sub-basement, which require less heat than the space above ground. Assuming that only 50 per cent. of the heat per unit of volume is required and figuring the entire building as above ground, it would bring the coal consumption up to 7855 tons, as compared to the 8100 tons given by the rule. As a rough approximation the rule appears to give results very close to the actual in this particular case.

In Chicago, a constant of 1 lb. instead of 0.9 is often used, and naturally, as it is colder there than in New York City, and the heat value of the average coal is lower.

Adding the roof area to the wall surface of the store gives 339,000 sq.ft.; then substituting in Rule 3,

$$\frac{\frac{339,000}{4.5} + 2 \times 240,000}{100} = 5553 \text{ tons}$$

This value is considerably lower than the actual tons of coal burned.

Taking the actual coal consumption of the building and dividing by the square feet of radiation, gives:

$$\frac{14,500,000}{160,000} = 90.6 \text{ lb.}$$

of coal per square foot of radiation. This is a little higher

than the 78.75 given by Mr. Durand, but might be expected, due to the colder climate and the poorer quality of coal generally used in Chicago.

A small factory building, 100x100 ft. and 90 ft. high, with windows in the two ends and the side walls blank, used 250 tons, or 500,000 lb. of coal. The cubical capacity of the building is 900,000 cu.ft. By Rule 2 it would require 405 tons, and by Rule 3, 235 tons of coal, the latter being nearly correct.

From the foregoing it would appear that Rule 2 is correct for large buildings and incorrect for small structures; while Rule 3 is just the reverse. It must be borne in mind, however, that the contributor who sent in the above data has taken two buildings representing extreme cases and they may be the proverbial exceptions that prove the rule.

The figures given are averages and not absolutely correct. It would be interesting to hear from other readers of POWER as to how these rules check with results obtained in their plants.

Live-Steam Connections to Exhaust-Steam Heating System

The Apr. 15 issue of POWER contained an article by Charles H. Bromley entitled, "Some Troubles of Steam-Heating Systems." In the second paragraph the author suggests a method of connecting the live- and exhaust-steam mains to avoid excessive use of live steam for heating. I overcame the same trouble in another manner which I believe simpler and more economical.

The system, using exhaust steam at ½ lb. pressure was

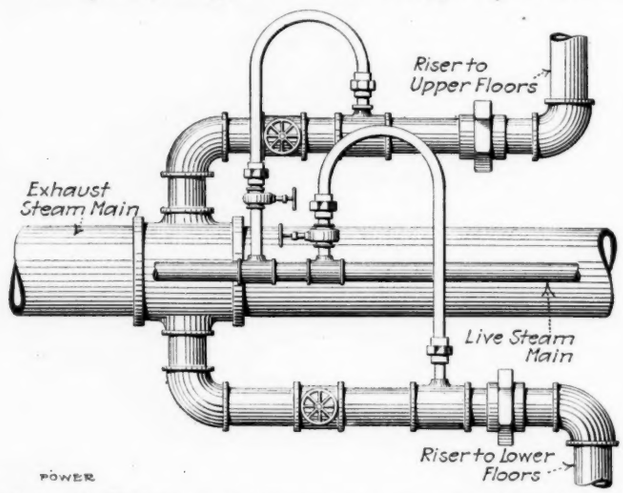


FIG. 1. TYPICAL CONNECTIONS BETWEEN LIVE-STEAM HEATING MAINS AND EXHAUST

installed in a six-story and basement factory building, the live and exhaust mains being horizontal were installed on the third floor of the building, extending around on all four sides near the walls and hard against the floor beams. From the exhaust main vertical risers were run to the upper and lower floors to ordinary pipe coils, each coil being controlled by a valve between the riser and coil. The returns were connected to a common riser, one on each side of the building and these in turn were connected to a horizontal return in the basement and this connected to the feed-water heater.

The live-steam main, 1¼ in. in diameter, was located alongside of the exhaust main, as shown in the accompanying sketches. The feature is the connection between the live and exhaust mains, as shown in Fig. 1. The connections are ½-in. pipe bends, with valves located, as shown, to control the flow of steam.

This arrangement admits no live steam into the exhaust main, except when desired, and gives control of the

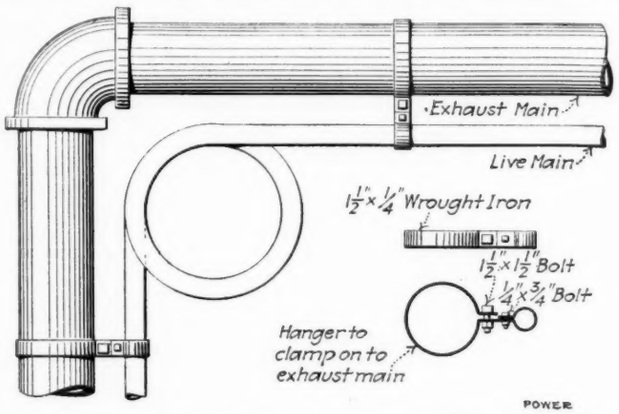


FIG. 2. LIVE-STEAM PIPE CLAMPED TO EXHAUST MAIN

steam so that it can be directed to any coil or coils in the system independently of all other coils.

An additional feature of the live-steam main consists of a loop or pipe bend, as shown in Fig. 2. This allows for expansion without an expansion joint and also obviates water-hammer. The method of hanging the live-steam pipe to the exhaust main is also shown in this sketch.

This system has been in constant use for more than six months and is giving perfect service.

B. R. LEEDS.

Philadelphia, Penn.

Commission Control of Public Utilities

Satisfactory rates and good service would be the rule if all utilities held the same views as D. L. Gaskill. Following are a few paragraphs from his paper read before the National District Heating Association, at Indianapolis:

"The State Utility Commission, appointed by the highest power of the state, with jurisdiction over the whole of the state, opened up the way for the solution of the trouble between the people and the utility. After a few years' experience with the state commissions when they have been given ample funds and power, most of the ill feeling and distrust existing between the utility and the public has disappeared and a feeling of coöperation and confidence has taken its place.

"Under the so called home rule doctrine that is being put forward in some states as a progressive step, the value of utility control is in grave danger of being destroyed. Local control of utilities will have neither the power nor knowledge to prevent duplication of plants and will be generally subject to the popular but false idea that competition in utility service brings low prices. Where there is state utility control, sufficiently complicated to draw broad-minded men to its service, such errors would not be permitted.

"Under intelligent state control, we may expect eventually to have all the intricate problems of utility management worked out to a standard.

EDITORIALS

Government Plants

The government is showing increasing interest in the central-station and the isolated-plant question. Secretary of the Treasury McAdoo has awarded the contract for an installation to furnish heat, light and power for the federal building in Chicago, in which the post office is located. This is a consequence of an expert investigation, which revealed that a saving of ten thousand dollars a year to the government was possible. It is a source of gratification that the central station, which had been supplying the current for light and power, could not hold the business even by offering a rate far below what it is charging other Chicago consumers and wielding all the political influence it could bring to bear.

The success and economy of the plants already in use in government buildings seems to have decided the Secretary to extend the system of government plants to other large structures. If this is so, the State House in Trenton deserves attention. There a plant nearly large enough to run the building remains idle with all the standing charges against it, and men enough to run it are employed to run the boilers for heating and nearly, if not quite, coal enough to run it is burned under the heating boilers, while the State of New Jersey pays the Public Service Corporation six cents a kilowatt-hour for current.

Colliery Boiler Plants

While there are some exceptions, the power plants of most collieries do not compare favorably with those found operating manufacturing establishments. This applies particularly to the boiler room where operating conditions are far from ideal. Many such installations are very dirty with coal strewn thickly over the floor and ashpits nearly full of ashes. When the ashpit is cleaned out, but scant attempt is made to prevent mixing good coal with the ashes and throwing all out together. Then, again, neglect is indicated by the cracked condition of the boiler settings, especially where return-tubular boilers are used, and by badly cracked furnace fronts and warped fire-doors. Many of the latter are so out of shape that it is impossible to shut them tightly.

Leakage of air through the cracked boiler setting into the combustion chamber and an excessive amount of air leakage past the furnace doors above the fires produces but one result, improper combustion.

If the exteriors of the boilers show neglect, it is natural to assume that the interiors are no better, and, if so, many of them are evidently operating under dangerous conditions. The few colliery plants operating without this neglect of economy and safety, for some are kept clean and orderly, by contrast, reflect the greater discredit on the rest.

Reasons for this state of affairs are cheap coal, indifference, ignorance and lack of opportunity. The first three probably have much more to do with the effect than the last named.

None of these reasons is sufficient to excuse the situation. Even if the coal is cheap, it is worth as much in the plant coal bin as on a car ready for shipment. If a ton of coal is worth a dollar when ready for the market it is worth a dollar in the boiler room. Every ton of coal needlessly consumed in the boiler furnace is a dollar thrown away.

Let a good fireman ask for a ten-cent increase in wage and the probabilities are that his request will be refused. Let him needlessly waste a ton of coal and nothing is said.

How do you account for this Mr. Superintendent? Is it not because the one item will show on the operating charges against the plant in dollars and cents, while the other is charged against the plant operation as just coal?

An increase in the selling price of coal is maintained by the mine operators as justifiable, because of the increased cost of production, but has any attention been given to the economical operation of the power plant, which produces the steam and power necessary as an element in economical production? We believe not in a large number of installations.

Is not the boiler plant left in the hands of men who are coal handlers rather than men capable of keeping the boilers in proper condition? Although neglect plays an important part in the conditions existing in so many of these mine plants it would appear that ignorance regarding boiler economy and safe operation is largely responsible.

The superintendent of a mine has enough to do with matters pertaining to coal movement without being obliged to attend to boiler operation. The solution of the problem would be to place such plants in charge of competent men, who would be held responsible for economical operation, and then back them up in their endeavors to produce desirable results.

The Engineer's Chair

One of our readers recently asked if an engineer's chair was a desirable adjunct to an engine room and questioned the advisability of reading while on duty. It appears that the management at his plant had ordered the chair and table to be removed and had denied the employees the privilege of reading while on duty. As he put it, eight hours was a long time to be on foot, and besides the order was a serious reflection on the faithful discharge of duty by the staff.

Our opinion would be that it all depends on the man, and his attitude toward his work. The efficient, uninterrupted and safe running of the plant are the first considerations. The man who is an engineer because he has a lively interest in his work and enjoys to the full "the inner compensation which goes with duties well done" is unlikely to abuse either the privilege of sitting down or of reading while on duty. If he does read it is something

which will help him directly in his work and not the latest cheap novels or copies of trashy periodicals. To keep up with the times and make himself more valuable to his employer, reading the current literature in his field is an absolute necessity, and whether he reads some or all of it at the plant depends upon the conditions, the efficiency of his co-workers and, as we have said before, upon his own character and disposition.

In some instances there may be a tendency to sit too long, and this will be apparent in the man who has no interest in the plant beyond keeping clear of a shutdown or in the man who grouches along day by day with one eye on the clock and the other on his pay check at the end of the month. Such an employee bears watching and should not be afforded facilities to make himself too comfortable. In any event he will not do any reading of the right kind, and ten chances to one will neglect his duties anyway.

He is not the man to be trusted in a plant in any capacity, and rather than to make a ruling concerning the utilization of his leisure moments, it would pay the company to replace him with a trustworthy employee.

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Breakdown-Service Rates

According to *The Isolated Plant,* more than one hundred owners of private power plants have signed a petition to be presented to the Public Service Commission asking that body to fully investigate the existing rates of the New York Edison company for breakdown service, in case the company refuses to consider the question of arbitration. These owners have promised financial assistance for carrying on a suit, if necessary, in an attempt to obtain a just rate for such service.

Breakdown service is desirable as a safeguard against the possible failure of the isolated plant. It is conceded that a just rate for such service should be charged to cover the cost of installing the service, interest on the investment and for the protection the service affords.

At the present rate charged in New York City the users of breakdown service practically guarantee to use thirty dollars worth of electricity per year for each kilowatt of maximum demand. This means that if the owner of an isolated plant having a maximum capacity of two hundred kilowatts has a central-station connection to his switchboard as a precaution against shutdowns, he guarantees to pay for six thousand dollars worth of electrical energy during the year, no matter whether he uses it or not.

Naturally, the central station does not seek for nor favor this kind of service. It would prefer to put the isolated plant out of business. But it is a legitimate service for the consumer to demand, and the central station, in its capacity as a public utility ought to furnish it at a fair profit upon the cost of its rendition.

One of the excuses for the high rate demanded is that the central station must put in a kilowatt of extra capacity for each kilowatt of stand-by service which it takes on, must have extra boilers, generating units and help ready to furnish all of this current on an instant's demand. As a matter of fact they do no such thing. It is inconceivable that every isolated plant having stand-by service could break down at the same time, and at that time all be running at their maximum capacity. The electric company should not be allowed to charge overhead costs upon more than the actual reserve capacity held for stand-by service, and this apportioned upon the plants so served. It should be allowed a fair profit upon the service so tendered based upon its actual cost, and it should be compelled to furnish such service at a price which would yield such a profit, regardless of whether it wants to or not.

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Signs of the Times

Continually increasing demands for high-grade power-plant equipment, capable of sustained high economy, have caused builders of it to make greater efforts than ever before to develop and perfect more economical apparatus.

Manufacturers of steam meters and feed-water meters, CO_2 recorders, recording-pressure gages, thermometers, pyrometers, etc., have met the demands of the progressive engineers, and new devices for indicating and recording operating data are being developed. Tube cleaners and scrapers, and feed-water compounds and treating apparatus are finding more extensive application. The practice of buying coal on the basis of the number of heat units it contains is spreading.

These are the external signs of the times. They point to changes in the practice of plant design and operation. Originally, almost the only aim was to keep the wheels turning. Now, however, with well perfected equipment available, more care is exercised in plant design, and low operating cost takes precedence over low first cost in the average case.

The Lazwell drainage-pumping plant, described in this issue, is a fair example of the improvements in design. As recent as ten years ago it would have been considered foolhardy to erect a plant of this character on a swamp for the sole purpose of pumping "ditch water." Almost any kind of machinery was usually considered good enough and the cheaper the better.

With improvements in design come greater skill and knowledge in operation. The raw materials, coal and water, are better understood and now it is not uncommon to analyze them systematically to the end that the one may be purchased and used more satisfactorily and the other may be suitably treated when needful to prevent waste through incrustation and corrosion.

The advantages of keeping close account of operating economy are fast being recognized and used; hence the increasing demand for instruments and gages to point to bad symptoms before too great inroads have been made in the coal pile.

Much progress has been made but much more still remains to be made. And a large part of this remainder is within the province of the operating man.

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A metropolitan daily commenting editorially on New York City's smoke nuisance, says:

"The volume of the nuisance maintained by the Hall of Records is not so great as that charged against the New York Edison Co., but the smoke-stacks of the latter organization are greater."

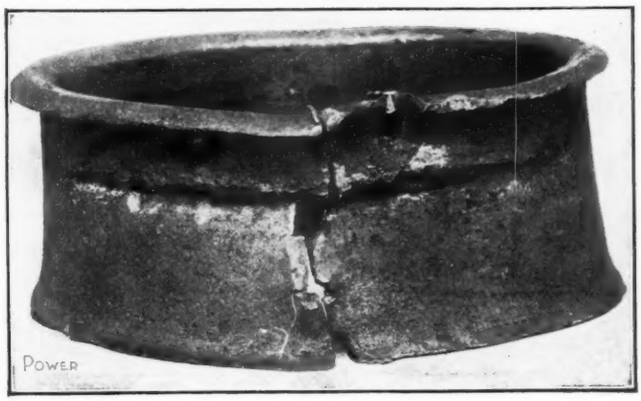
The conclusion reached is that the more stacks the more smoke, regardless of the amount and kind of coal burned, the way it is burned, and, in fact, whether or not any at all is burned! A smoke-stack simply *must* smoke.

READERS WITH SOMETHING TO SAY

Why Do Boiler Tubes Become Grooved?

The photograph shows the corroded end of a 4-in. tube taken from a horizontal tubular boiler. Five tubes in one boiler and two in another were taken from our boilers recently. The corroded tubes were all most seriously affected on top, the bottoms being but slightly corroded.

The groove in the tube end shown was so deep that it penetrated clear through in one place. The thickness



CORRODED END OF BOILER TUBE

of the tube at the bottom of the groove is less than $^1/_{64}$ in.

It would be of interest to read discussions as to the cause of grooves forming in tubes. It will be understood that the thickness of the boiler head is ½ in., and that the grooves form close to the head on the inside of the boiler.

SYDNEY WHITAKER.

Granville, Ill.

Why Not a Higher Vacuum?

We have an old-style engine running condensing and the most vacuum we can obtain is 10 in. The engine is of the double poppet-valve type, 16x42 in., making about 78 r.p.m., and taking steam about ⅝ of the stroke. The exhaust pipe is 8 in. in diameter and all packing around the rods seems to be in good condition and the exhaust line is tight. Recently we repacked all the tubes on both ends of the condenser.

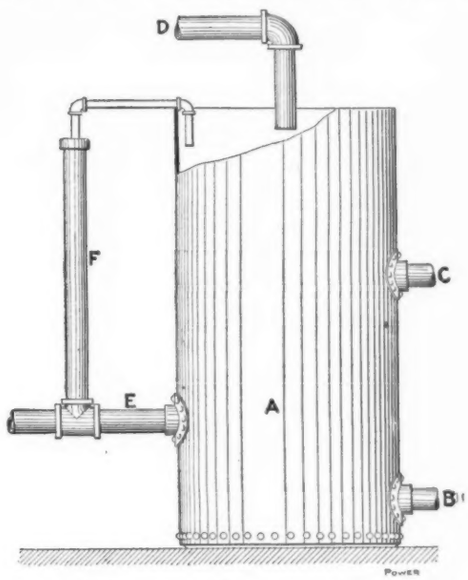
The condenser has 320 three-quarter-inch tubes, 8 ft. long, and has a partition running through the center. The intake is at the bottom and the outlet at the top. We have three 8-in. deep-well pumps delivering water to the condenser. The circulating water is about 58 deg. F. entering, and about 90 deg. leaving the condenser. Is the condenser too small? Could not the intake of the condenser be on top instead of on the bottom, and what difference would it make?

Rockport, Ind. WILLIAM H. SHEW.

Vent Pipe Prevents Water-Hammer in Heater

To stop the annoying water-hammer in a feed-water heater, I made changes in the piping as described below:

In the illustration *A* is a sheet-iron tank used as a hotwell, *B* is the feed-pump suction, *C* is the overflow to the sewer, *D* the makeup-water line, and *E* is the return main from a pair of dryers. Originally cold water was used as makeup water and the noise resulting from its use was intolerable. I changed the cold-water connection *D*, so as to feed hot water to the tank. This stopped the noise some, but not entirely, so I got after it again and put a 5-ft. length of 3-in. pipe *F* in the tee in the return main *E*, and reduced to 1¼ in. to vent it back into the



VENT IN HEATER TO PREVENT WATER-HAMMER

tank. There is very little noise now, as the steam that is in the return water can expand in the 3-in. riser and pass over to the tank.

R. Y. BUERGER.

Somerville, N. J.

Piston Sticks and Breaks in Cylinder

While shutting our plant down for repairs this summer we had a 26x48-in. engine cylinder rebored and a new piston made for the same. The work was done by a local concern. When the new piston was placed in the cylinder, it lacked about $^1/_{64}$ in. of being a snug fit. The engine was started and run about five hours with a very light load. During this time we were using an inferior grade of cylinder oil which, we afterward found out, was sent by mistake. When the maximum load was reached and the governor had increased the cutoff from $^1/_8$ to about ⅜ of the stroke, there was a slight chattering-like motion of the connecting-rod. A few minutes later the

piston broke into 50 or more pieces without doing any further damage to the engine.

My opinion is that the piston broke, due to its expansion caused by not making proper allowance for the increasing temperature. Insufficient lubrication caused excessive friction between the piston and the wall of the cylinder, thereby raising the temperature above that due to the pressure of steam.

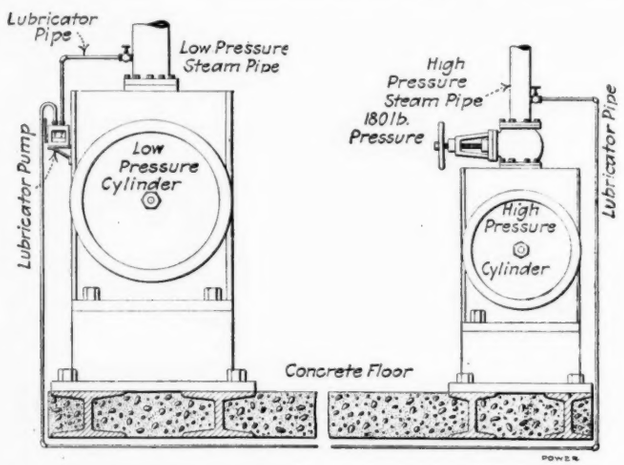
The piston stuck and stopped and the momentum of the flywheel forced the rod through the piston.

J. W. Dickson.

Memphis, Tenn.

Lubricator Improperly Located

While employed in a large railway power plant, we experienced considerable trouble with the lubrication of the high-pressure cylinder and valves of a 2000-hp. horizontal cross-compound Corliss engine. The oil pump was located on the outer side of the low-pressure cylinder, the latter being about 12 ft. distant from the high-pressure cylinder, as there was a large generator and flywheel on the engine shaft between the main bearings. This distance between the cylinders made it necessary to have 40 ft. of ¼-in. pipe from the oil pump to the high-pressure cylinder. The pipe led down the outer side of the low-pressure cylinder through the floor and across under it to the outer side of the high-pressure cylinder and up to an inlet in the steam pipe over the throttle valve on top of the high-pressure cylinder.



Oil-Pump Connections on Cross-Compound Engine

Most check valves leak more or less after being in service for a time, especially if under high pressure. As the pressure was 180 lb. in this case, it happened that after the engine was shut down for a number of hours, the pressure on the high-pressure lubricator inlet would force the oil through the leaky check valves and back through the pipe into the lubricator pump, condensed steam taking the place of the oil in the pipe. Then on starting, it would require possibly an hour's running of the engine at full speed to pump the oil back through the 40-ft. pipe. This unsatisfactory condition made it necessary to use the more or less wasteful hand-pump lubricator on the high-pressure cylinder at frequent intervals for an hour or more after starting the engine to get sufficient oil to the piston and valves.

The oil pump was transferred to the outer side of the high-pressure cylinder, thus reversing the arrangement and doing away with further trouble as there was no pressure on the low-pressure side to force the oil back toward the pump.

Edward W. McGregor.

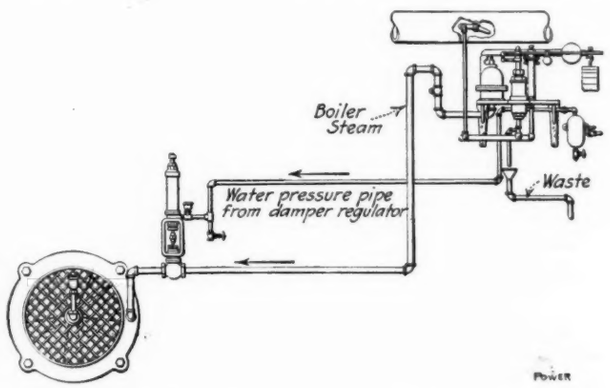
Panama Canal Zone.

Automatic Control for Draft Fan

The accompanying illustration shows an automatic arrangement I made to control the fan blower for a boiler plant.

Nearly all installations of engine-driven forced-draft outfits for boilers are automatically controlled by a damper regulator or diaphragm valve, and the arrangements of levers, valves, chains, pulleys, rods, etc., to accomplish this purpose are sometimes marvelously intricate and usually the more levers there are the more troublesome is the device.

My system appears to be free from the objections to which chains, pulleys, guides, etc., are heir. It consists of a diaphragm valve installed in the steam-supply pipe to the blower engine or steam-jet blower, the diaphragm chamber of which is connected by a ⅜-in. pipe to the chamber of the damper regulator on which comes the pressure to move the damper-regulator piston.



Fan Blower Controlled by a Damper Regulator

When the steam pressure rises to the point for which the regulator is set, water pressure is admitted to the damper piston, also through the ⅜-in. pipe connection to the diaphragm on the steam valve and closes it, thus shutting down the blower. In case the blower is run by an engine which must keep turning over to prevent stopping on the center, a bypass valve can be provided past the diaphragm valve and this bypass adjusted for the proper speed.

In practice this diaphragm valve can be provided with a weak spring so it will close before enough pressure accumulates to move the damper and also be the last thing to open.

Any number of similar valves can be operated by the one damper regulator and at any distance, around corners, etc., the only expense being the waste of the water the diaphragm holds at each operation; even this can be returned to the supply tank.

B. S. Remlieu.

Brooklyn, N. Y.

A Radical Cure for Hot Bearings

The main bearings of our cross-compound engine are 16 × 32 in. fitted with the usual babbitted top shell, and, besides the 50,000-lb. fly-wheel, they carried the armature of a 500-kw. generator.

This bearing, which was on the high-pressure engine, had given trouble from the start, and I was told when coming to the plant that this machine had never been run to speed (100 r.p.m.) longer than a few hours, and then the bearing ran very hot, necessitating the removal of the shells and cutting out of the oil grooves. I had the engine started, and, after running a short time, the generator was cut in on the line. In a few minutes smoke was seen coming from one of the handholes in the bearing cap before heat could be felt at either of the handholes in the cap.

The load was reduced, the machine taken off the line and the speed lowered to the point of turning over slowly. By this time the heat had come out on the end of the shaft, so the hand could not be held upon it.

Desiring to learn where the trouble started and not being a believer in the use of a top bearing shell, I prepared at once to do away with it by having the carpenters make a frame to place over the quarter bearings, the two side pieces of the frame being notched to receive the end pieces. While the carpenters were doing this I took off the shell and found the oil grooves well plugged. I cut open the grooves and scraped the bearings. Everything was then replaced except the top bearing shell. After this the engineer was able to run his hand the entire length of the journal and tell where the heating started.

The machine was again started and shortly after was heating just as much as before. I removed the cap and the quarter bearings, and using a flat chisel with faces ground to a long angle, and holding the chisel at a right angle to the journal, I cut along the entire length, turning up a "fin." I then smoothed the ragged edge with a file, my object being to use this fin to cut out the babbitt metal by turning the engine over. I did this with the quarter bearings out, after which I wiped away all the babbitt. I peened the fin down smooth, using a fine file for finishing the surface. The job proved to be a success from the start, and that was the best running bearing in the engine room.

P. A. Stafford.

Aransas Pass, Tex.

[With extreme care a skilled man might be successful with such a method. Severe cutting would result if chips from the shaft remained in the bearing.—Editor.]

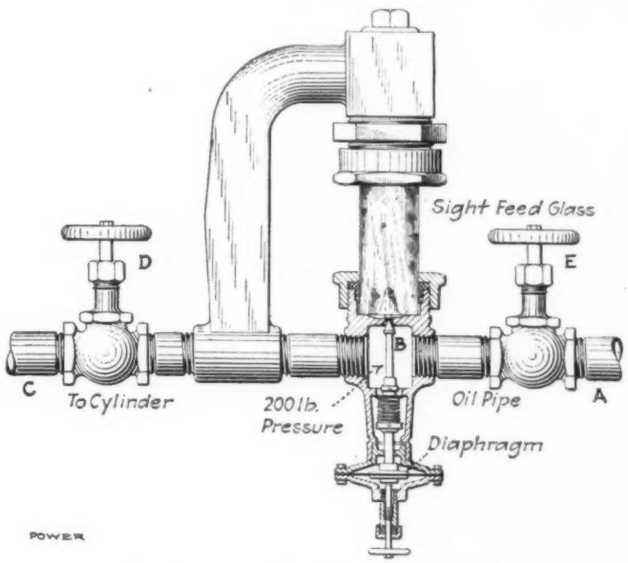
What Becomes of the Water?

The accompanying sketch is an illustration of our sight-feed oilers for lubricating the engine cylinders.

Referring to the diagram, the oil enters the pipe *A* under 200 lb. pressure, passes through the regulating needle valve *B*, through the sight-feed glass and out through *C* to the cylinder. *D* and *E* are globe stop valves. All but two oilers work perfectly. These are located on the high-pressure cylinder of a 1500-hp., tandem-compound engine. With these two oilers the water will disappear from the sight-feed glass almost every time the engine is shut down, the oil remaining and soiling the glass so that every morning I have to blow out the glass, and allow more steam to condense.

This has been getting rather monotonous, so lately I have had the night engineer close the valve *D* just before shutting down the engine, and so far have had no more trouble.

However, this does not explain where the water went to. These two oilers are connected to the steam chests



Lubricator That Gave Trouble

of the engine, all the rest are connected above the throttle so that they are subject to full boiler pressure at all times. The two causing the trouble are subject to boiler pressure while the engine is running and about 25 in. of vacuum after the steam has been shut off and the engine turned over a few revolutions.

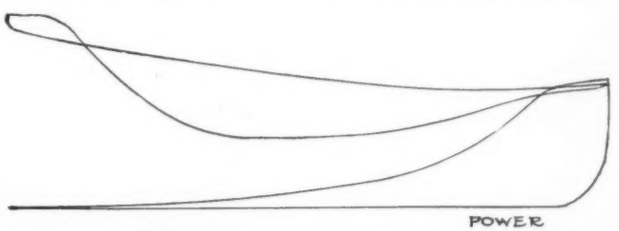
The only possible explanation I can give is that the sudden drop in pressure, when steam is shut off, causes the water to evaporate in the glass. The quantity lost, however, is over half the total in the glass, and it does not seem possible that the heat in the water will account for this much.

Thomas G. Thurston.

Chicago, Ill.

Indicator Diagrams for Comment

The accompanying indicator diagrams surely are unusual. They were given to me by an engineer at one of the plants in our town, and all the information that I can



Defective Indicator Diagrams

give is that they were taken from a Corliss engine with a 70-lb. spring, and the size of the cylinder is 18x36 in. The engine runs at 68 r.p.m. I would be pleased to have readers comment on the diagrams.

John T. Sharp, Jr.

Canton, Miss.

QUESTIONS BEFORE THE HOUSE

Advantages of the Steam Turbine

In the article, page 514, of the Apr. 8 issue, J. S. Leese, designates many of the turbine's good qualities, but he does not give the turbine all the credit it deserves. If he had handled large reciprocating sets and then turbines of corresponding or larger sizes he would fully appreciate other factors which he omitted. For instances, the stand-by losses are considerably less than with reciprocating sets; the turbine can be handled with less help, and can be brought from a cold state into service while warming a reciprocating set. The packing troubles are cut to a minimum and the only moving parts requiring attention are those connected with the oil pump and governor gear.

Then the consumption of oil is much less, and frequent adjusting of bearings is eliminated, unless there has been heating. The exhaust condensate can be returned direct to the boilers without traces of oil. Foundations are cut down to a minimum; in fact, a girder-constructed platform to allow the condenser to be placed underneath, with either lead or felt placed between the sole plate and girders, is all that is required.

A number of drains are done away with and there is less danger of damage being done if a slug of water happens to come over from the boilers. These favorable points added to those given by Mr. Leese only do the turbine's cause partial justice.

From my experience many turbine spindles are distorted from the effects of leaky valves while idle and too long a time taken in warming up with the machine stopped. The correct way to warm up is to get the machine turning over very slowly on the warming valve; if the warming valve is not large enough to start the rotor a puff of steam from the main stop valve can be applied, the machine then being kept turning over with steam from the warming valve. Particular notice should be taken that neither of these two valves are leaking, as the hot steam playing on the rotor in one position for a long period is likely to cause local distortion.

E. Russell Pearce.

Rochdale, England.

Volumes of Frustums

In the Mar. 11 issue of Power, page 355, is given a rule for finding the volume of a frustum of a pyramid or cone. It should be noted that this rule does not apply to frustums of wedges, and, therefore, the solution of the first problem directly under the rule is incorrect. The foundation described is a frustum of a wedge but not of a pyramid.

It may be further remarked that it is not often necessary to actually extract the square root in applying the rule as the numerical terms may usually be arranged so as to avoid this operation. In the second example, we find that

$$\sqrt{B \times b} = \sqrt{(300^2 \times 0.7854) \times (260^2 \times 0.7854)}$$

The expression under the radical can be grouped as follows:

$$300^2 \times 260^2 \times 0.7854^2$$

The square root of this expression is obtained by simply dropping the exponent 2 from each factor. Hence

$$\sqrt{B \times b} = 300 \times 260 \times 0.7854$$

The average man dislikes to extract the square root or to multiply large numbers. By following the plan suggested above the labor involved in the operation is minimized.

The prismoidal formula* can be used in obtaining the volume of frustums and has a wider application than the ordinary rule, but apparently is not so well known.

M. D. Gravatt.

Scranton, Penn.

Why Boiler Tubes Leak

Answering the inquiry by E. H. Hart, in the May 20 issue, I would advise that several reasons can be suggested as the cause of boiler tubes leaking at their ends.

Perhaps the fire-doors are left open over night to keep the steam pressure down, allowing a large quantity of air to circulate around the shell of the boiler, and it would perhaps hit the tube ends, causing them to leak. There may be defects in the brickwork around the back end of the boiler, and cold air may get through and strike the tube ends. The feed-water pipe may be installed in such a manner that cold water entering the boiler discharges against the tube ends. Mr. Hart does not say whether the tubes are corroded or just loosen and leak.

James E. Noble.

Toronto, Ont., Canada.

Replying to E. H. Hart, as to trouble with the outside tubes of boilers leaking at the ends. I would state that these tubes, being the more inaccessible, probably are heavily scaled. This would cause undue heating and leaking of the tubes at their ends. It is a difficult problem at times to get at the outside tubes.

John F. Hurst.

Louisville, Ky.

Pumping Air Exhaust of Mine Pump

On page 577 of the Apr. 22 issue is a letter by Mr. Houston on "Piping Mine-Pump Air Exhaust." He says the pump in question, which is a 12 and 6 by 13-in., works against a 400-ft. head. This would be equal to a pressure of about 173 lb. per sq.in.

The maximum air pressure is given as 90 lb. per sq.in., and, of course, would be still less at the exhaust end. Mr. Houston states that the pump is started by turning the exhaust to the atmosphere until discharge takes place through the regular discharge pipe, after which the ex-

*The use of this formula is explained in the Study Questions, June 4, 1912.

haust is turned into the latter. As there is a check valve on the exhaust pipe to prevent a flow of water to the air end of the pump, it looks as though air at 90-lb. pressure can be depended upon to open a valve against a water pressure of 173 lb.

The only way that I can see how such could be done is to get the exhaust into the discharge pipe before the static-head pressure of the water reached the given air pressure. Or, if the discharge pipe were full when the pump was to be started, it could be drained off to the required head.

Of course, when the pump is once in operation as described, the head pressure will not be that due to 400 ft., as the action of the air would tend to be the same as in an air-lift system. This would mean that there would be alternate layers of water and air all the way up in the discharge pipe.

This would bring about a condition that Mr. Houston should experiment with regarding the effect on the capacity of the pump. A given flow of water and air mixed would mean a lesser pump capacity than if the pipe contained only water. But as the pressure would be reduced owing to the presence of the air, the velocity of flow would be increased with a given pump speed.

J. A. CARRUTHERS.

Hosmer, B. C., Canada.

Regarding the method of piping the exhaust and discharge from a mine pump explained by Mr. Houston, in POWER of Apr. 22, 1913, I felt at first with Mr. Bridges (POWER, May 27, 1913, p. 755) that I had one on the editor. However, before I got through I had thoroughly satisfied myself that Mr. Houston was correct.

The point seems to be that after making the new connections the pump does not begin to work against the 400-ft. head, but instead the pipe from the pump to the surface is empty. As the water begins to rise in the pipe, the air from the pump begins to exhaust into the pipe too, thereby lessening the average specific gravity of the column contents against which the air must exhaust. The air discharged by each stroke of the pump would be eight times the volume of water discharged if it expanded only to an average of 37½ lb. gage pressure. If all eight volumes of the air remained in the pipe there would be room for only 45 ft. of water column, equivalent to only about 20 lb. gage, which would allow for a still greater expansion of the air. As a matter of fact, equilibrium would be reached by a certain amount of air rushing up past the water, but theory seems to point to a big leeway for this process. Even after the pump was originally started with the new connections, and then shut down, the pipe would not remain full enough of water to prevent again starting the pump, added to which, it is always possible to bleed the line before restarting. If the pump had to be started with the 90-lb. air exhaust piped in against a 400-ft. water column, Mr. Bridges is right, there would be "nothing doing," but it does not work that way.

DONALD M. LIDDELL.

Elizabeth, N. J.

Comments on Flue-Gas Readings

The statement made by F. A. Lowe under the title, "Flue-Gas Readings for Criticism," in POWER of May 20, 1913: "It will be noticed that a minus sign is put before some of the CO readings. This sign indicates that the CO reads less than the O" seems to need some explanation. All of the CO readings are less than the O readings. If the statement should mean that the CO reads less than zero, it is probably to be explained by the use of an old cuprous-chloride solution, which gave up some of its CO to the gas being tested.

DONALD M. LIDDELL.

Elizabeth, N. J.

Best Form of Link

Referring to the problem of S. N. Bowman, page 642, May 6 issue, as the bending stresses in the links would depend on their own weight they should be of I-beam section, so as to combine the greatest stiffness with the least area of cross-section. The dimensions of their cross-section would depend on the permissible vertical motion of the suspended weight after its impact, as upon impact there would be a shortening of the distance between the suspending pins, due to deflection of the links, and the amount of that deflection would depend upon the specific weight and bending resistance of the material employed for the links.

A. T. KASLEY.

Swissvale, Penn.

Referring to the problem submitted by S. N. Bowman, in the May 6 issue, it is a law of mechanics that when a body descends from one horizontal plane to another, without friction, then when it has reached the lower plane its velocity will be the same as if the body fell freely from the one plane to the other, no matter what path is followed. This means that the weight at the instant the blow is struck will have the same velocity that it would have by falling 10 ft. from a position of rest. Therefore, the velocity at impact will be

$$v = \sqrt{2gh} = 8.02\sqrt{10} = 25.34 \textit{ ft. per sec.}$$

The centrifugal force of a body revolving about a point is

$$F = \frac{mv^2}{R}$$

where

m = Mass = $\frac{\text{weight}}{32.16}$;

v = Velocity in feet per second;

R = Radius in feet.

Hence the centrifugal force of the descending weight is

$$F = \frac{\frac{15{,}000}{32.16} \times 25.34^2}{18} = 16{,}640 \textit{ lb.}$$

To this must be added the weight of 15,000 lb., making a total tensional stress of 31,640 lb. on the four rods or links, which is

$$31{,}640 \div 4 = 7910 \textit{ lb. per link}$$

Owing to the jar at the instant the blow is struck the factor of safety should be high and on this point engineers would probably differ somewhat. However, if the links were of wrought iron, a load of 5000 lb. per sq.in. would certainly be within the limit of safety, which gives

$$\frac{7910}{5000} = 1.58 \textit{ sq.in. or say } 1.6 \textit{ sq.in.}$$

as the minimum area of cross-section of each rod. Taking

the weight of 1 cu.in. of wrought iron as 0.28 lb. and allowing 2 ft. on each link for the eye, the four rods will weigh about 450 lb., which does not add enough to the load supported to make a second calculation of area necessary. Hence, wrought-iron links having a cross-section of 1.6 sq.in. each will be strong enough as far as tensional stresses are concerned.

When the weight strikes, the centrifugal force ceases at once, therefore, any other stress that might occur will arise from the effect of stopping the motion suddenly. As the weight hits squarely and horizontally no vertical stresses will be set up, which leaves only the motion of the links to be considered. The kinetic energy of a moving body is found by multiplying the weight by the square of the velocity of its center of gravity and dividing the result by 64.32. The velocity of the center of the rod is one-half that of the lower end; hence

$$\textit{Kinetic energy of the four links} = \frac{450 \times 12.67^2}{64.32}$$

$$= 1123 \textit{ ft.-lb.}$$

This energy is given up while the weight is moving 2 in., or as the center of the links is moving 1 in. $= \frac{1}{12}$ ft. Now bearing in mind that the retarding force multiplied by the distance through which it acts equals the kinetic energy of the rods,

$$F \times \tfrac{1}{12} = 1123$$

or

$$F = 13{,}476 \text{ lb.}$$

that is, the inertia of the rods at the time of impact, causes a force of

$$13{,}476 \div 4 = 3369 \textit{ lb.}$$

per rod, provided the center of the rod comes to rest after moving 1 in. As a matter of fact, however, the links will vibrate or spring much more than this and it would not be unreasonable to expect an 18-ft. rod a little more than 1 in. in diameter, to spring 2 in. or even more at the instant of impact, so that the actual horizontal force from this cause would probably be less than 1000 lb. per rod. With the low terminal stress allowed, a link of round cross-section and of cross-sectional area to safely take care of the stress of tension will be amply strong enough to provide for any other stresses that will occur in this case. If the links are made of flat iron, they should be made so that the flat side is perpendicular to the plane of motion. Otherwise, severe stresses may be set up at the instant of impact.

An intricate theoretical discussion may be woven about this problem, but I have considered it as a practical example and have used a practical method of solving it. Slightly different results, no doubt, can be obtained by other methods, but the results here are close enough for all purposes.

W. G. Hawley.

Scranton, Penn.

Valve Setting

Mr. Walchli's theory (page 614, Apr. 29 issue) that the engine should be turned opposite to the action of the connecting-rod to locate points *A*, *B* and *C* in his sketch is correct for putting the engine on center, as lost motion in the crankpin and the crosshead pin should be taken up on each side of the center by rotating the wheel so as to strain the connecting-rod in the same direction as when the engine is running.

The statement of the "Power Handbook" refers to the way of putting the engine on the center to adjust the valve. The booklet is correct in stating that lost motion of the eccentric, valve rod, etc., should be taken up by turning the wheel in the same direction as when the engine is running. With *C* properly located it makes no difference whether lost motion is greater in one place than another, as, in locating the point *C*, the valve is not being adjusted, and when setting the valve, *C* is already located and the connecting-rod could then be disconnected.

However, any engine needs keying up if it has enough lost motion in either place to make any noticeable difference which method is used.

Harry D. Everett.

Fort Apache, Ariz.

Preventing Cylinder Condensation

The article on page 705 of Power, May 20, relative to cylinder condensation and the remark contained therein as to it being common for engineers to run engines with the drip valves open, or partially so, leads me to suggest a remedy I have employed successfully to overcome this practice.

The plan consists simply of the installation of automatic cylinder cocks. I have obtained excellent satisfaction by the use of these cocks on slow- and moderate-speed slide-valve engines, especially on low-pressure cylinders exhausting into a vacuum in which case the outlet or drain from the cock should be connected to the exhaust pipe between the condenser and exhaust valve.

These cocks also work well on noncondensing slide-valve engines as, being connected to the lowest point, they permit the accumulated condensation of each stroke to be blown out of the cylinder without the loss of any steam.

The drainage pocket illustrated in the article referred to would require special and peculiar design for use on any cylinder having four rotary or Corliss valves. In this style of cylinder it would appear that the exhaust port in the cylinder, being in the bottom at each end, should form practically just such a pocket or well having a cubical capacity the clear length, width and the depth of exhaust port from cylinder counterbore, into which the exhaust port opens to the top of the exhaust valve.

W. Oliver.

Racine, Wis.

Losses Due to Compressor Piping

The story with the title quoted above, as told by A. D. Palmer, on page 611, in the issue of Apr. 29, is somewhat puzzling. With an insufficient supply of steam at too low a pressure the compressor ran at 200 r.p.m., while with plenty of steam at a higher pressure it ran at only 125 r.p.m. At the higher speed the air pressure maintained was 20 to 40 lb., while at the lower speed the pressure was 50 to 70 lb. In both these particulars the results reported are exactly the reverse of what should have been expected, and it would seem that some additional explanation would be in order.

Frank Richards.

New York City.

INQUIRIES OF GENERAL INTEREST

Foot Valve—What is a foot valve.

P. M.

A foot valve is a check valve such as is usually placed at the lower end of a pump suction pipe to prevent the water in the pipe from running down when the suction is not in action as between strokes, or starts and stops.

Oil in Gas Collector—On the surface of the water in a collector for flue-gas analysis samples, oil is used. What is it for and what kind should be used?

J. W. D.

The oil forms a seal and prevents the water from absorbing any of the elements of the gas sample. An ordinary machine oil may be used. How to use it is told in a letter by Robert H. Schafer, "Another Serviceable Gas Collector," in the Dec. 17, 1912, issue of "Power," page 910.

Suddenly Opened Valve Effect—What effect would it have on the water line of a boiler to suddenly open a stop valve or safety valve?

P. C.

If the valve is opened suddenly while the boiler is under pressure, the water line of the boiler would rise, for steam would be suddenly liberated in the body of the water of the boiler and in ascending to the steam space, the steam would tend to lift the whole body of the water.

Steam Generation Temperature—At what temperature will steam begin to be generated in a boiler filled to the running level with water at 35 deg. F. and the steam space filled with air at 100 lb. pressure?

L. C. S.

So far as the temperature at which steam will begin to be formed is concerned these conditions are no different than if the boiler were in regular operation at 100 lb. steam pressure. The temperature will, therefore, be that found in steam tables corresponding to a pressure of 100 lb. gage or 338.1 F. In this case the water will have to be raised through a temperature range of

$$338.1 - 35 = 303.1 \text{ deg.}$$

Number of Staybolts Required—If the area of the segment of the head of a tubular boiler above the tubes is 714 sq.in., and the steam pressure is 100 lb. gage, how many 1⅛-in. braces would be required of a working strength of 7500 lb. per sq.in. of cross-section?

F. M.

The total pressure to be resisted is

$$714 \times 100 = 71{,}400 \text{ lb.}$$

A 1⅛-in. diameter stay would have a cross-sectional area of 0.994 sq.in. Then its allowable strain is

$$7500 \times 0.994 = 7455 \text{ lb.}$$

and the number of stays required is

$$\frac{71{,}400}{7455} = 9.57$$

or the next largest whole number, ten.

Removing Boiler Tubes—What is the proper way to remove tubes from a vertical tubular boiler and what is the best way to put in new tubes?

L. M. N.

The common way to remove tubes is to cut the ends with a cape chisel. One end of the tube is slit through and is then collapsed enough to drive it into the boiler so that the tube may be removed through the tube sheet on the opposite end of the boiler. Care must be taken not to injure the sides or edges of the tube holes, otherwise it will be difficult to make the new tubes tight. To remove tubes from an upright boiler without throwing it over on its side, the tubes are detached from the furnace-tube sheet, and sufficiently loosened in the upper flue sheet to withdraw the tubes through the top. New tubes have to be expanded into the tube sheets, preferably using a roller expander. Beading is done with a thumbing tool, which must be handled with care to avoid splitting the tube ends, especially if the tubes are not of the best quality.

Engine Pound—There is a clattering noise in our engine cylinder occurring at the ends of the strokes. Is this due to condensation, and if so, how can it be remedied? It is a Corliss engine and has no cylinder cocks.

J. P. M.

As shown by the diagrams sent with the inquiry, steam is expanded down to and probably at times below exhaust pressure. The noise is, therefore, likely due to the exhaust valves being subjected to pressure on the reverse side at the end of each stroke. Lowering the initial pressure would stop the trouble, and, if it is not convenient or desirable to decrease the boiler pressure, the admission may be throttled, which would have the additional advantage of insuring dry steam, so that if there were trouble from condensation it should be removed also. Another remedy is to crack the indicator cock so as to prevent the pressure in the cylinder from becoming less than that in the exhaust pipe. This would be advisable only if the initial pressure cannot be reduced enough to prevent expanding to such a low terminal pressure.

Increased Boiler Horsepower—If a boiler 5 ft. 3 in. long containing 134 tubes, 2¼ in. in diameter, is retubed with 2½-in. tubes, how much is the horsepower increased?

P. C.

A 2¼-in. tube has a circumference of

$$2\tfrac{1}{4} \times 3.1416 = 7.068 \text{ in.,}$$

and a 2½-in. tube,

$$2\tfrac{1}{2} \times 3.1416 = 7.854 \text{ in.}$$

The 2½-in. tube is, therefore,

$$7.854 - 7.068 = 0.786 \text{ in.}$$

greater in circumference and the length of the tube being 5 ft. 3 in., or 66 in. the increase of area, using 134 tubes is

$$\frac{0.786 \times 66 \times 134}{144} = 48.27 \text{ sq.ft.}$$

Allowing, according to modern commercial rating of tubular boilers, a boiler horsepower to each 10 sq.ft. of heating surface and the new tubes would increase the horsepower

$$\frac{48.27}{10} = 4.827 \text{ hp.}$$

Or, by the old rating of 15 sq.ft. per hp.,

$$\frac{48.27}{15} = 3.22 \text{ hp.}$$

Variation of Boiler Efficiency with Load—What are the comparative efficiencies of a boiler at different percentages of rated capacity? What is the greatest capacity at which it would be desirable to operate a boiler continuously?

S. C. A.

Under ordinary good conditions of operation and good proportions, with clean boilers, the highest efficiency is usually obtained when forced to about 50 per cent. excess of normal capacity. At one-quarter capacity boilers will generally yield about three-fourths the efficiency of 50 per cent. estimated capacity and their efficiency gradually increases up to 150-per cent. capacity. At 200 per cent. a boiler will usually give a higher efficiency for a short time, or until the flues become dirty, requiring extraordinary cleaning. It is never advisable to overload a boiler more than 50 per cent. as the grates, furnace linings, walls and many parts are likely to be damaged when used at furnace temperatures exceeding those for which they were designed.

If the boiler has been set with the size of grate, kind of setting, etc., appropriate for a given capacity, it would not be desirable to operate it at any higher capacity continuously even though higher efficiency might be obtained, as the parts are likely to be injured and any advantage gained would be likely to be more than offset by the greater care and attention for cleaning, repairing, safety, etc., that would be entailed.

Errata: Vacuum at High Altitudes—In the answer to the inquiry under the above title in the June 10 issue, the mistake was made of subtracting 0.03 lb. from 9.8 lb. instead of adding it. The pressure should have been 9.83 lb. per sq.in., which would balance

$$9.83 \times 2.0355 = 20.009 \text{ in.}$$

of mercury instead of as given before 19.887 in. The error is not serious in amount nor does it affect the final statement.

ENGINEERS' STUDY COURSE

Making a Flue-Gas Analysis

Following are the solutions of the problems in the last lesson. Applying the formula given in the same lesson as the problems we have

$$C \times 14{,}600 + \left(H - \frac{O}{8}\right) 62{,}000 = 0.6365 \times 14{,}600$$

$$+ \left(0.0526 - \frac{0.1012}{8}\right) 62{,}000 = 11{,}773 \textit{ B.t.u. per lb.}$$

In the second problem the sum of the percentages of volatile matter and fixed carbon is

$$35.51 + 50.06 = 85.57$$

and dividing this into the percentage of fixed carbon and multiplying the quotient by 100 gives

$$\frac{50.06}{85.57} \times 100 = 58.5$$

the percentage of fixed carbon in the combustible. After locating the 58.5 point at the bottom of Fig. 2, in the last lesson, tracing an imaginary line straight up to the curve and then horizontally across to the left margin, we find that the heat value per pound of combustible matter is 14,975 B.t.u. Then, as but 85.57 per cent. of the coal in the problem is combustible matter, the heat value per pound of coal is

$$14{,}975 \times 85.57 \div 100 = 12{,}814 \textit{ B.t.u.}$$

Value of Flue-Gas Analysis

Thus far we have been studying fundamental principles only and, no doubt, many have wondered what was the use of lumbering up their brains with such matter if it could not be put to some practical use in plant operation. Beginning with the present article we will take up the application of these principles and after we have mastered a few more, we will be able to apply all of them to good advantage in securing greater efficiency in boiler operation

Let us assume that we have succeeded in discovering the best coal, all things considered, for our plant. By making proximate analyses and estimating heat values we have found one grade of coal which has minimum moisture and ash; consequently, it gives maximum heat-generating material per dollar invested. Upon actual trial in the boiler room it is found to work satisfactorily with the existing equipment. It does not clinker badly and, hence, the firemen can handle it easily and efficiently and maintain the steam pressure uniform without undue trouble.

Our next problem is: How best to burn this coal so as to get most of the heat it contains into the boiler and generate the greatest quantity of steam possible per pound of coal fired. And right here is where our knowledge of the underlying principle of combustion comes into use.

Excess Air Necessary

In preceding lectures it was shown that each pound of coal of a certain composition requires a certain fixed weight of air for complete combustion and the method of figuring this weight was given. But, this theoretically required amount of air will not suffice in the boiler plant because if only the required amount is supplied, the distribution must be perfect so that each particle of oxygen in the air may come in contact with a particle of carbon or hydrogen. If this does not take place, some of the oxygen will escape without combining with its allotted share of the combustible matter, with the result that either of the two following things may happen: Some of the hydrogen may escape unburned, or some of the carbon may be only partly burned and form CO instead of CO_2.

In the boiler plant this perfect distribution of the oxygen is impossible. Consequently, an excess quantity of air must be supplied to the fuel in the furnace in order that complete combustion of every particle of the burnable matter may be effected and no loss suffered from combustible gases escaping up the chimney.

Importance of Knowing Required Excess

Now, too much excess air is equally or even more detrimental to good economy than too little. Assume a given coal requires 10 lb. of air per lb. of coal for complete combustion and that the gases formed weigh 10.75 lb. The heat value of a pound of this coal is, say, 10,000 B.t.u. Immediately after combustion all this heat is contained in the 10.75 lb. of gases and due to this fact their temperature is very high. We are not ready just yet to estimate how high, so let us assume the temperature to be 3500 deg. F. As these intensely hot gases come in contact with the heating surface of the boiler and give up their heat to the water within, their temperature falls until it reaches, say, 500 deg. as the gases leave the boiler. The gases are still much hotter than was the air and coal which went to make them up and as they obtained their heat from the coal, all the coal's heat did not go into the boiler to make steam, but some was lost up the chimney.

Now, if 20.75 lb. of air were fed per pound of coal, instead of only the required 10 lb., double the quantity of gases would pass from the boiler. And as these gases would escape up the chimney at about the same temperature as the 10.75 lb., the heat loss would be about double that in the first case. This is true because with equal temperature the heat contained in 21.50 lb. of gas is just double the amount contained in 10.75 lb.

Thus, it is important to discover just what amount of excess air is most economical under the existing conditions in your plant and in order to know this some means must be employed to measure or calculate the air supply to the boiler.

Estimating Air Supplied

Direct measurement would be difficult to make and unsatisfactory in accuracy. A far easier and more accurate means is to analyze the flue gases and calculate the air supply from this analysis and the coal analysis. Flue-gas analysis is also useful in checking boiler opera-

tion from day to day so as to be sure conditions will remain economical.

Simplicity of Flue-Gas Analysis

Somehow or other, flue-gas analysis has a very mysterious and forbidding sound. People are inclined to think it is too deep and dark for them to understand and, consequently, many have not made the good use of it that they should. As a matter of actual fact, it is simple to understand and easy to master. The trouble has been, however, that apparently no one has taken the trouble to explain the case fully and thoroughly. This is just what Power now aims to do. And right here perhaps is a good place to remind you that if what we print in this department is not perfectly clear to you or if you cannot succeed without further assistance, do not hesitate to write for help or advice. You letter will be welcome; it will be turned over to the writer of these lectures and treated confidentially.

Apparatus Required

A suitable apparatus is required for making a flue-gas analysis. Numerous types are on the market all of which have points of merit. Most of them, however, are based on the Orsat apparatus which was designed by a man of that name and which has been so extensively used that the name has come to be almost as typical as such names as Corliss, Babbitt, etc. For this reason, the principle and operation of the Orsat only will be given here.

Following is a list of the essentials of a flue-gas analyzing outfit:

1 standard Orsat-Muencke flue-gas analysis apparatus	$20.00
2 rubber gas bags for pipettes @ 50c. each	1.00
2 large glass bottles, @ 50c. each	1.00
2 rubber corks for bottles @ 15c. each	0.30
10 ft. antimony rubber tubing (¼ in.) @ 10c	1.00
10 ft. of ¼-in. glass tubing in 5-ft. lengths @ 2c	0.20
4 Mohr's pinch cocks @ 8c. each	0.32
1 German-glass funnel (2-in. size)	0.10
1 lb. caustic potash (purified sticks)	0.35
¼ lb. pyrogallic acid	0.10
1 lb. commercial copper oxide	0.55
1 lb. muriatic acid	0.30
10 ft. copper wire No. 10 gage @ 10c	1.00
Total	$26.92

There are several different makes of Orsat apparatus, such as Orsat-Muencke, Orsat-Lunge, Orsat-Fischer, etc. But all are based on exactly the same principle and differ only in regard to minor details of construction. For instance, the Orsat-Fischer has four pipettes instead of three. Just what a pipette is will be clear presently.

❖

All predictions of past years that coal could not be worked at a greater depth than 1500 ft. no longer hold water. At the present day, according to W. E. Garforth, president of the British Institute of Mining Engineers, coal is being mined at depths exceeding 3000 ft. The adoption of a system of long-wall working has solved the question of superincumbent weight. The coal is exposed to this weight for a very short time and places are closed up rapidly.

❖

For the increase of the Birmingham, England, municipal electric supply, it is proposed to erect a new power station at Nechells, with an ultimate capacity of 100,000 kw., of which 10,000 are to be available for the winter 1915-16. Marine type water-tube boilers, fitted with superheaters and overhead economizers are to be erected. Ashes are to be removed from the boilers by a new system operated by air suction. The cost of the first installment of the station, including the extensions required in substation equipment for the next five years is estimated at $2,346,000. The Summer Lane station (25,500 kw.) is also to be increased to 36,500 kw. capacity next year. The stations at Water St. and Aston have 3040 and 4550 kw. capacity, respectively.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Right up to now, we believed that "imitation is the sincerest flattery." Now we're skeptical—having seen the calendar of the Viscosity Oil Co. It's well named, and literally: Anything viscous is ropy and glutinous, which may be the reason it roped our "What the Diagrams Tell," published in 1910, and glut(t)inously adhered to it in every detail but one—it did not photograph the word "Power" along with the rest of the chart. If the Viscosity Oil Co. has an explanation to offer, all well and good. If not, we'll take it for granted that it's willing to stand by its apparent ignorance of the meaning of the word "etnics." We say ethics because it sounds so real polite; it could be made stronger.

❖

Our much esteemed contemporary, "Factory," is as meaty, juicy and appetizing as a porterhouse steak. But——. If we have earned our right to be critical, we ask where in Tophet did that cubist artist get the idea on the front cover that a tornado of smoke typifies a busy factory? The more fire the less smoke is Hoyle today.

❖

Nothing is more unconsciously hypocritical, remarks Dr. Talbot, than "We have done a great deal for our employees." The good doctor says it should read: "We have done a great deal to make conditions favorable for profitable work." The lay public has been so completely carnegied into the belief that every man who spends a dollar on bettering his plant or shop is a philanthropist, that it is refreshing to have the actual truth. Hooray for the doctor!

❖

WHAT'S IN A NAME?

By Billy B. Damm

In a manner of speaking, the Bard of Avon called the turn in "Othello," when he remarked, "He that filches from me my good name robs me of that which not enriches him and makes me poor indeed." But it must be a good name, and opinion differs as to what constitutes a good name. Now, there's Orlando Dammit, of Elmsford, N. C. He wants the state solons to change his. The jokesmiths, wanting to heckle Orlando, ask why.

I ask Dammit, why NOT? Dammit, why not? I'd change it. Let's see: O. Dammit—Orlando D. Mit—O. Mit— I can't get it, Dammit. But cheer up, Dammit. Dammit, cheer up! Say, Orlando, supposing you— It's no use, Dammit; see the legislature, but steer clear of those lobbyists Blankitt and Dashitt.

Your not alone, Dammit, in your difficulty. We once knew a grocer—nice fellow, but a little light weight—whose sign read:

"A. SCHWINDLER"

He really wasn't, but folks kept saying so. It was suggested that he get a new sign and spell out his Christian name, the first in ancient history. The new sign he nailed up read:

"ADAM SCHWINDLER"

You certainly haven't forgotten the Dam family, Giv. A. Dam, fat Willie Dam, Lena Dam and Godfrey Dam? Think of this crowd going to hear Wagner's opera of "Goetterdaemmerung"!

Gretchen Schwein, in my home town, up and married Milton Hogg, and the envious began to wonder how she could have made a Hogg of herself.

Helga Johansen went to school with me—a real nice, jolly girl, and we called her Helga. Some of us fondly called her Hel—just like Liz, for Lizzie, and Gwen for Gwendolyn. We'd see a girl down the street starting off for school, and Tommy Rott would say: "Billy, that looks like Hel!" Well, she did and she didn't. Many of the fellows would go to Hel with their troubles, she was that sympathetic. She afterward married a chap named Biers, who drank himself to death.

There's lots in a name, depending on the point of view. I knew a man who gave his to seven different ladies. When he had done his six years he told me that he had made up his mind to settle down—he'd already settled up with the irate seven—and get married.

Traugut Walsingham's mother named him after her grandfather, so that the boys couldn't nickname him. They called him "Gutsy" his first day on the street.

What's in a name? You can search me, as Blink Boffum said when asked where all the bugs went in wintertime.

Steam-Boiler Efficiencies

By A. Bement*

SYNOPSIS—Answer to William Kent's criticisms of the experiments on transmission of heat into steam boilers made by Henry Kreisinger and Walter Ray for the Bureau of Mines.

Under the above title, William Kent, in the October issue of the *Engineering Digest,* severely criticizes experiments described in the Bureau of Mines Bulletin No. 18, entitled "The Transmission of Heat into Steam Boilers," by Henry T. Kreisinger and Walter T. Ray. In addition, he charges the bureau with wasting money and effort in executing this work. The research was a worthy one. Its execution was in the hands of those who originated it. The research had the unqualified endorsement of Prof. L. P. Breckenridge, who had charge of the steaming tests, and his influence was an important factor in advancing the experiments.

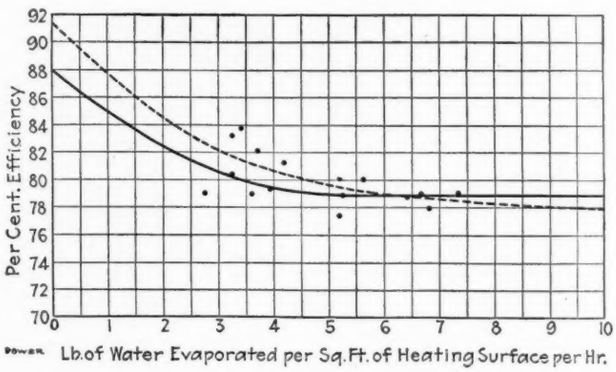
Mr. Kent quotes from an earlier Bulletin, No. 325, page 178, as follows: "The authors see no reason why boilers cannot be constructed and probably operated with entire satisfaction, which will produce about ten times the amount of steam now obtained per square foot of heating surface and with no difficulty in obtaining dry steam." And he says that five years later, in Bulletin 18, the authors do not repeat this "extragavant" statement, but are content with the milder one that "the present steaming capacity can be tripled and quadrupled by forcing over the heating surface three or four times the weight of gases now passed over them."

The writer's understanding is that, when the authors made the first statement, they had in mind the belief then held by many people that boiler capacity is limited by the capacity of the metal-heating surface to convey heat from the receiving to the delivery side of the plate. What they probably meant was that the heat transmitting capacity of the plate or tube is at least ten times the capacity usually expected of it; there is no evidence that this statement is not true. Before the bulletin containing the statement was published, Mr. Ray made for me an estimate of the power necessary to force sufficient gases through a boiler to insure the large capacities in question and his figures showed that, long before a capacity ten times greater than usually obtained was secured, the entire steam production of the boiler would be required to furnish power for the draft, even with the most efficient fans.

Most of their experiments were made with a very small boiler, a piece of laboratory apparatus. The heat was furnished by wire coils electrically heated. Air passing over these coils carried heat to the boiler surface. This arrangement enabled an exact regulation and avoided the dangers of incomplete combustion incident to any form of fire. Thus it eliminated the troublesome variables which cause confusion and lead to erroneous conclusions in experiments with large boilers heated by combustion. Hence the small boiler was justified, notwithstanding Mr. Kent's argument that a large boiler should have been employed.

The authors make prominent what they call "true boiler efficiency," which allows for the contents of a boiler being hotter than the atmosphere, for which reason less heat will flow into it than if it were at atmospheric temperature. All heat in the gases below the steam temperature would not be available to the boiler and is not charged to it in the true boiler efficiency. Whether this particular expression is justified and some other would have been better, may be questioned, but not the fact above stated, yet Mr. Kent presents several examples in an effort to disprove it. Apparently he considers this "true efficiency" analogous to constant efficiency, because his calculations which give a discordant result instead of a constant one, embody several variable conditions, such as initial temperature, capacity and steam temperature.

Mr. Kent states that "a steam boiler has no efficiency which depends only on the structure." This seems to be his principal disagreement with those adopting newer



Variation of Boiler Efficiency with Capacity

views on steam-generator performance. Evidently he holds to the old theory that has denied individuality to the boiler, and insisted that instead of its being a definite part in steam-generating apparatus, a "boiler" includes boiler proper, fire bars or stoker, brick walls, fire, chimney, etc. He states that it can have no efficiency which is not dependent on its operation, meaning that of the combined apparatus plus condition of combustion, which includes all the possible variables, as imperfect combustion, fuel lost in ashes, excess of air, etc.

When such an eminent authority as Mr. Kent states that a boiler can have no efficiency based on its structure, argument to the contrary calls for positive proof. In the latter part of Bulletin 18 are some examples of large boiler performance corroborating experience with the small boilers. One is that of boilers in the plants of the Commonwealth Edison Co., in Chicago. These were of the box-header water-tube type, having no baffles nor division plates within the tube surface.

The hot gases entered at the bottom of the tube surface in the rear and left at the top in front. One boiler had two horizontal baffles inserted, as shown at page 157 of Bulletin 18, which caused the gases to flow in a much more restricted channel than before, and to traverse a distance of 36 ft. in contact with the tube surface, instead of 13 ft. in the unbaffled boiler. The two boilers were in the same battery and otherwise identical. There-

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fore any difference in their performance must be due to the difference in baffling.

In the tests, the baffled boiler had one-third less draft in its furnace than the other, due to the resistance of the baffling, yet it evaporated 5 per cent. more water, and with only two-thirds as much of the same coal. One of these boilers absorbed more of the heat flowing through it than the other, and did so because of its structure, for the fire, as shown by gas analysis, was the same for each boiler.

The basic claim of Messrs. Ray and Kreisinger is that the velocity of the gases has an important influence on the flow of heat into the boiler. In this connection Mr. Kent quotes from Bulletin 18 the statement that "the efficiency of a boiler as a heat absorber can be increased by arranging the heating surfaces in such a way that the gas passages are long and of small cross-section," which he says, "is merely a deduction from unproved hypothesis." Nevertheless, this is just what was done with the Commonwealth boilers. That Mr. Kent makes no reference whatever to the work of Prof. John T. Nicolson, the tests of the Interborough Rapid Transit Co. and Commonwealth Edison Co., which are all with "actual boilers," is strange, considering a review of Bulletin 18, in which these appear, could not properly ignore these experiments.

That the velocity of the gases has an effect is apparent without the evidence of such tests. An object at lower temperature will be heated faster by a flowing current of hot air than by air without motion, just as a person gets colder if the wind blows than if it is still, the temperature being the same.

Three Principal Elements

As I look at the matter, the efficiency of a boiler is based on three principal elements as follows:

1. Form of gas passages, causing the hot gases to come in contact with more or less heating surface.
2. Time in which the heated gases are in contact with the heating surface.
3. Velocity of the hot gases in their flow through, or in contact with the heating surface.

Upon this basis the operation of the triple-flow boiler of the Commonwealth Edison Co., may be defined as compared with the single-flow boiler as follows:

A. The multiplicity of passages carried the gases into contact with more heating surface.

B. The contracted areas necessarily increased the velocity.

C. The length of travel of gases being greater than the increased velocity, they were consequently among the heating surfaces a longer time.

As I understand the conclusions of the authors of Bulletin 18, they consider that when capacity has passed a certain point, efficiency becomes constant. Before that point is reached, however, it decreases as capacity increases. Thus efficiency would drop as capacity increases until this point is reached, after which it would become constant. Mr. Ray informs me that with the single-pass Heine boilers used at the St. Louis Exposition, the point of constant efficiency began at an evaporation of 6.9 lb. of water per square foot of heating surface per hour. When the same boiler had been double-passed by the insertion of one baffle, efficiency became constant at an evaporation of 4.3 lb. of water per square foot. Also that with an average 2-in. locomotive boiler tube, constant efficiency is reached at a capacity of 3.5 lb. evaporation. These figures are, no doubt, based on average furnace action; variation in condition of combustion would have a corresponding effect on the efficiency of operation.

In an attempt to throw some light on this problem, I have analyzed the very excellent and important tests made by Doctor Jacobus on the large boilers in the Delray station of the Detroit Edison Co. The results, as he presented them in a paper before the American Society of Mechanical Engineers, are efficiency of operation based on coal as fired, but I have recalculated the tests on the basis of coal as burned, neglecting incomplete combustion of hydrocarbons, a small but unknown quantity. Only those tests for which a heat balance was made are available. The result is shown in the accompanying diagram. Two curves have been drawn. The broken one best fits the points, and shows efficiency declining as capacity increases throughout the full range of tests.

Unfortunately, however, for this version of the matter, extending the curve to zero evaporation, at which point the gases would leave at steam temperature, it intersects the ordinate of zero capacity at an impossible efficiency. If in drawing the curve, it is started at 88 per cent. efficiency, certainly as high as permissible, it necessarily takes the form of the full line, indicating that efficiency becomes constant at an evaporation of four pounds.

I feel that we should not condemn this work of the Bureau of Mines unless there is more ground for it than critics have yet advanced. If the full-line curve in this diagram presents the truth, it is certainly a matter of the greatest economic importance, so great in fact that if the the whole cost of the Bureau of Mines to date be charged to this one investigation, it would be had at low price.

Ample corroborative proof is available for the support of all claims of the authors of Bulletin 18, except that of a constant efficiency, and while my diagram is not conclusive, I hope this discussion may lead to further study of the matter.

Chicago Federal Plant

During the Taft administration experts investigated the possible saving to the government by furnishing its own light and power as well as its heat in the federal building in Chicago, containing the post office.

Although their report indicated that $10,000 a year could be saved, political influence and a proposal from the Commonwealth Edison Co. to reduce the charge led Secretary MacVeagh to pass the question to Secretary McAdoo. The latter has shown his decision by awarding a contract to the Harrisburg Foundry & Machine Works for the engines and generators at a cost of $42,000. This is taken to be a declaration of the present administration's policy in matters of the kind and it is anticipated that there will be many more additions to the number of plants already operated by the government.

Many engineers assume that most boiler explosions are caused by some mysterious influence which cannot be foreseen or guarded against, but as a fact, a definite cause can be given for most explosions of considerable violence. That a larger percentage of boiler explosions are due to causes that might have been foreseen and prevented, is a well estabishd fact.—"Southern Engineer."

American Order of Steam Engineers Convention

The twenty-seventh annual convention of the American Order of Steam Engineers and the eighth annual exhibition of the American Supply Men's Association were held in Odd Fellows Temple, Philadelphia, Penn., June 2 to 6.

THE DELEGATES AT THE PHILADELPHIA CONVENTION OF THE A. O. S. E.

On Monday morning there was a session of the supreme council and the delegates were seated. Hon. Rudolph Blankenburg, mayor of Philadelphia, officially opened the convention and the exhibition in the evening.

After a brief session on Tuesday, an enjoyable boat trip on the steamer "Thomas Clyde" was taken, the party returning to the city at 6 o'clock.

There were two official sessions on Wednesday, and in the evening at 8 o'clock a reception and entertainment were given under the auspices of the American Supply Men's Association. This proved a most enjoyable affair and was well attended.

Thursday afternoon's program included a trolley trip and outing to Maple Grove Park, with the usual athletic events and amusements. An interesting feature was the ball game between the engineers and the supply men. The engineers won, the score being 9 to 7.

On Friday evening the closing session of the supreme council was held. The following supreme officers were elected for the coming year:

Chief engineer, George W. Goodwin, Baltimore; first assistant engineer, Harry Tallifeare, Atlanta; recording engineer, William A. Hardin, Atlantic City, N. J.; correspondent, Edward Reboul, Germantown, Penn.; treasurer engineer, Michael Helmstreit, Philadelphia, Penn.; senior master mechanic, Daniel Buntin, Philadelphia, Penn.; junior master mechanic, Charles O. M. Bear, Allentown, Penn.; chaplain, L. J. Callaway, Philadelphia,

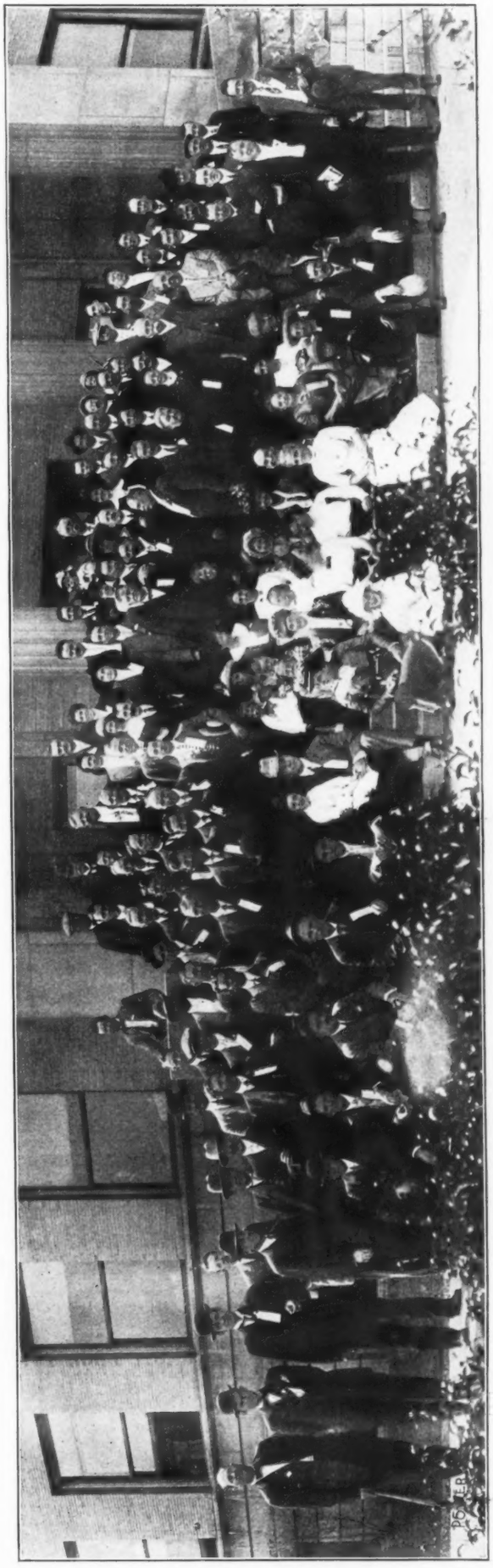
THE SUPPLY MEN AND GUESTS AT THE CONVENTION

Penn.; inside sentinel, Philip Kirkwood, Baltimore; outside sentinel, Henry Messer, Columbia, Penn.; trustee B. B. Heilman, Reading, Penn.

The next convention will be held in Baltimore.

The American Supply Men's Association elected the following officers: President, Fred L. Jahn; vice-president, Harry Souders; secretary, Charles A. Wilhoft; treasurer, John W. Armour; chairman of executive committee, Frank Martin; director of exhibits, Hart Hill.

The exhibitors were: Albany Lubricating Co., Anchor Packing Co., Armstrong Cork Co., Baseler & Heineken, Inc., S. F. Bowser & Co., Inc., F. H. Brown Packing Co., Buhne Metal Packing Co., Collieries Supply & Equipment Co., Cyrus Borgner Co., James V. Colpitts, Dearborn Chemical Co., Diamond Power Specialty Co., Joseph Dixon Crucible Co., R. & J. Dick, Ltd., Duemler & Co., Economy Fuse & Manufacturing Co., Engineering Supply Co., Fairbanks Co., Fisher Governor Co., Ford & Kendig, France Packing Co., Frick Grate Co., Garlock Packing Co., Greene, Tweed & Co., Griscom-Russell Co., Hawkeye Compound Co., Home Rubber Co., E. F. Houghton & Co., Paul B. Huyette Co., Inc., Hazard Manufacturing Co., Jenkins Bros., H. W. Johns-Manville Co., Kelly & Jones Co., Keystone Lubricating Co., Leavitt Machine Co., Local Steam Packing Co., the Lunkenheimer Co., Lagonda Manufacturing Co., McArdle & Cooney, McLeod & Henry Co., National Tube Co., Nelson Valve Co., George B. Newton Coal Co., New York Belting & Packing Co., POWER, Philadelphia Grease Manufacturing Co., Peerless Rubber Manufacturing Co., Philadelphia Bourse, *Popular Engineer,* Quaker City Rubber Co., E. J. Rooksby & Co., William C. Robinson & Sons Co., Frank H. Stewart, Schade Valve Co., Joseph F. Schiller, C. E. Squires Co., *Southern Engineer,* Texas Co., Travelers Indemnity Co., Trill Indicator Co., U. S. Graphite Co., H. B. Underwood Co., Vacuum Oil Co., Thomas C. Warley & Co., Watson & McDaniel Co., Elisha Webb & Son Co., Washburn & Granger, Samuel T. Wilson, Yarnall-Waring Co., Warren Webster & Co., Zurn Oil Co.



DELEGATES AND GUESTS OF THE ILLINOIS STATE N. A. S. E. CONVENTION

Illinois State N. A. S. E. Convention

The ninth annual convention of the Illinois State Association of the National Association of Stationary Engineers was held at Rockford on May 28, 29 and 30.

At the opening session on Wednesday, Rev. F. W. Lynch pronounced the invocation, followed by Mayor W. W. Bennett's address of welcome. National President John F. McGrath responded and other appropriate speeches were made by F. E. Carpenter, National Secretary Raven, John W. Lane, editor of the "National Engineer," and W. L. Osborne, president of the Central States Exhibitors' Association. State President John Morgan was then introduced and having called the convention to order appointed the various committees.

After the brief executive session in the evening the delegates joined the visitors at the Armory where the exhibit of the thirty-odd members of the exhibitors' association was held and an impromptu entertainment was given.

Following the business session on Thursday morning the delegates and visitors enjoyed an automobile ride to the several beautiful parks and other points of local interest. In the afternoon an excursion on the steamboat "Illinois" was taken to a grove 8 miles up the Rock River where a baseball game between the engineers and supplymen was settled in favor of the former with a score of 8 to 3. The winners are entitled to retain for another year the silver loving-cup trophy which was donated by the Supply Men's Association a year ago and which was won by the Chicago Engineers' Visiting Club last fall.

On Thursday evening, Prof. D. R. Mead, of the University of Wisconsin, was to have given a lecture on "Hydro-Electric Developments," but as he was unavoidably called away, Os-

born Monnett, chief smoke inspector of Chicago, lectured on "Smoke Prevention" instead.

The annual election of officers was held on Friday morning, resulting in the choice of the following: W. E. Hill, Rock Island, president; Fred G. Weller, Peoria, vice-president; G. Anderson, Chicago, secretary-treasurer; Henry Misostow, Chicago, state deputy.

The next convention will be held in Peoria.

Indiana N. A. S. E. Convention

The Indiana State Association of the National Association of Stationary Engineers held its ninth annual convention in Terre Haute on June 4, 5 and 6, with the Filbeck Hotel for headquarters. The mechanical exhibit by the Central States Exhibitors' Association and the convention sessions were held in the Knights of Pythias Temple. The first session was called to order by H. E. Smith, chairman of the local committee, at 9:30 a.m., Wednesday. Mayor Louis Gerhardt then welcomed the delegates and visitors to the city and National President John F. McGrath responded. After appropriate speeches by H. R. Ihrie, secretary of the Terre Haute Commercial Club, National Secretary Fred Raven and others, the supplymen's exhibit was formally opened by President Osborne, and a brief address was made by Past National President Charles W. Naylor.

In the afternoon visits were paid to the water works, the American Hominy Mills, the light and power station and the Prox Machine Co. In the evening Prof. F. Wagner, of the Rose Polytechnic Institute, gave an illustrated lecture on "Steam Turbines"

At the Friday morning session the following officers were elected: President, George R. Fields, Terre Haute; vice-president, Louis Minke, Evansville; secretary, Albert Franke, Terre Haute; treasurer, A. T. Arens, South Bend.

In the afternoon the delegates, visitors and supplymen enjoyed a 30-mile boat ride on the Wabash River; a fish fry was served on the boat.

Stevens Institute's Forty-First Commencement

The forty-first commencement of Stevens Institute of Technology, Hoboken, N. J., took place on June 10. Sixty-five men were graduated, each receiving the degree of mechanical engineer, the only degree conferred upon graduation.

The valedictory address was delivered by Jerome Strauss, of Brooklyn, N. Y., who was also honored with the distinction of winning the Stillman Prize in Applied Technology, which is annually awarded to the member of the senior class who prepares the best paper on a subject pertaining to applied technology. The subject for the prize paper selected by the Committee of the Faculty and open to competition among members of this year's graduating class was, "Advantages and Applications of the Low-pressure Steam Turbine."

Believing that our readers would be interested in reviewing Mr. Strauss' paper, we have arranged to publish an abstract of the same in an early issue of "Power."

Government Light and Power Plant for Chicago Post Office

Secretary McAdoo, of the Treasury Department, on June 2, ordered the installation of the Government's own lighting and power plant in the Chicago post-office building.

This action, ending a long controversy between the Treasury Department and a private contractor as to the ability of the Government to make a saving through the operation of its own plant, forecasts the possible extension of the policy to Federal buildings in other big cities, especially New York.

For Protection of Electric-Service Employees

The following requirements for the protection of employees of all public-service corporations in the jurisdiction of the Public Service Commission, First District (New York City), will be in force on and after July 1:

(1) All high-tension switch compartments shall, so far as their construction will permit, be so inclosed as to make it impossible, except when necessarily opening the compartments, for employees to come in contact with electrically charged parts either from or above the floor level.

(2) All exposed high-tension cables in power or substations shall be inclosed by screens or otherwise protected.

(3) There shall be posted, in conspicuous places in all the power houses and substations, diagrams describing and showing the relative location of wires and cables (except lighting and signal wires) and the switches, etc., controlling them and all such wires, cables and connections shall be so tagged and numbered that they may be readily identified.

(4) All machines for the generation of current or connected with such generation shall be so protected by railings and gratings as to safeguard operators and others from coming in contact with moving or electrically charged parts.

(5) There shall be at least two operators on duty in rotary-transformer stations delivering current at 500 volts or higher when the same are in operation.

(6) All water-level glasses or gage-glasses on tanks, standpipes, or other storage receivers under pressure, shall be protected by screens to prevent injury in case of a bursting glass.

(7) Test cocks on water columns shall be fitted with extension rods or chains so as to be operative from the boiler-room floor level.

(8) All stop valves on steam boilers shall be of the automatic self-closing type.

(9) Outlets of all safety valves shall be vertical.

(10) All furnace doors on hand-fired boilers shall be fitted with latches or catches to prevent them from being blown open.

(11) All moving parts of stokers shall be so protected, wherever possible, as to prevent accidental contact with such moving parts.

(12) All large main cutout stop valves shall be provided with means whereby the same may be closed from the boiler or engine-room floor or other remote point.

(13) All large steam units shall be fitted with automatic self-closing valves.

(14) All high-speed engines shall be fitted with automatic safety stops.

(15) Elevator wells shall be properly and substantially inclosed, secured or guarded and shall be provided with proper traps and automatic doors in or at all elevator ways so as to furnish substantial covering when closed and to open and close by action of the elevator when ascending or descending.

(16) All openings in floors shall be roped off or protected by railings when left unguarded, and, in addition, a red light shall be hung in the immediate vicinity when the location is unlighted or poorly lighted.

(17) All stairways shall be provided with safety treads, kept free from oil and water and be properly protected with hand-rails.

(18) Shafting running along or passing through floors shall be housed or screened or otherwise properly guarded.

(19) All belting shall be inclosed or otherwise protected wherever accidental contact is possible.

(20) Gear-case covers completely inclosing the gears shall be fitted to all machine tools and be kept in place while such tools are being used.

(21) Set screws and keys in exposed positions on moving machinery and shafting shall be countersunk or otherwise properly protected.

(22) Buzz saws and band saws shall be protected so as to prevent accidental contact with saw blades.

(23) Grinding and emery wheels shall be properly guarded and equipped with hoods and exhaust pipes to draw off finely powdered material.

(24) Guard glasses shall be provided for employees and used by them when engaged upon any work causing chips or fragments to fly, and wire screens of a portable or permanent type shall be set up on work benches or around employees engaged in chipping.

(25) A sufficient number of pails of clean, dry sand must be kept in all power stations, substations, auxiliary and switching stations.

(26) Power stations, substations, auxiliary and switching stations shall be provided with a sufficient number of chemical fire extinguishers of such a type that the contents cannot act as an electrical conductor. No other extinguishers shall be kept for use unless conspicuously labeled that they are not to be used until current has been shut off.

(27) All power stations, substations, auxiliary and switching stations and shops shall be provided with a first-aid or emergency kit.

(28) Provision shall be made whereby pulmotors will be available in case of accidents.

And it is further ordered that on or before June 1, 1913, said companies and said receivers adopt, promulgate and thereafter rigidly enforce rules and regulations to govern their employees in the handling of high-tension apparatus and in the handling of steam and mechanical apparatus in power stations, substations and shops.

SOCIETY NOTES

The next annual meeting of the National Conservation Congress will be held in Washington, D. C., Nov. 18, 19 and 20. Especial importance attaches to the selection of Washington for the reason that certain private interests opposed to conservation have recently sought to make it appear that there is lack of harmony between the Conservation Congress and the Conservation Association. That Washington was chosen after consultation between officers of both organizations shows that the congress and the association are working as a unit with identical aims. There are already indications of a record attendance.

Under the active administration of President Charles Lathrop Pack, the work of the National Conservation Congress is making gratifying headway. One of his most important steps was the appointment of a forestry committee of which the chairman is Henry S. Graves, Chief Forester of the United States Government. The work is being briskly advanced by this committee.

An important phase of conservation to be considered at the Washington meeting involves the tremendous fire waste in the cities of America. At the request of the National Board of Fire Underwriters, the Executive Committee has agreed to give place on the program for discussion of this momentous question. The vast loss to the country through preventable fires will be shown in concrete and comprehensive form and means will be considered for minimizing this unnecessary waste.

"Undoubtedly, the live questions of forestry and water power will dominate this year's congress," said President Pack. "Already the lines are being drawn for a fight. This is shown by misleading reports which the common enemy of conservation have been scattering to the effect that there might not be harmony between ourselves. As to water power, the Conservation Congress has always held that the remaining sites in the hands of the Federal Government should not in any way pass to the use of private interests without safeguarding the treasure now the property of the people. The report of the able committee on water power will be awaited with great interest. They are to report at the November meeting in Washington."

PERSONALS

I. Mhyre Hofstad, St. Petersburg, Alaska, has been appointed agent for that territory for the Blanchard Machine Co., Cambridge, Mass., manufacturers of oil engines, marine and stationary.

John Kollin, for several years sales manager with the Patterson-Allen Engineering Co., has been appointed general manager of the Monarch Specialty Manufacturing Co., New York City, which manufactures and deals in engineering specialties.

H. L. Watson, a member of the American Society of Mechanical Engineers, formerly sales engineer with the Allis-Chalmers Manufacturing Co., Milwaukee, has accepted the position of sales manager for the De Laval Steam Turbine Co., Trenton, N. J.

H. P. Bouslog, formerly chief engineer of the lighting plant of the Interstate Public Service Co, Shelbyville, Ind., has been appointed chief engineer of the power station of the interurban lines of that company, formerly the Indianapolis, Columbus & Southern Traction Co., at Edinburg, Ind., to succeed Levi Crater, who has resigned.

John R. Wilde has been appointed chief engineer of power plants for the Detroit Edison Co., succeeding B. J. Denman, who resigned May 1 to take up executive duties with the United Light & Rys. Co. at Davenport, Ia. Mr. Wilde has been in the service of the Detroit company for a number of years. J. W. Parker has also been appointed chief assistant engineer of power plants, sharing with Mr. Wilde the duties formerly discharged by Mr. Denman.

F. R. Low, editor of "Power," sailed for Germany, June 10, on the "Victoria Luise," of the Hamburg-American Line. He is a member of the official party of the American Society of Mechanical Engineers on its way to attend the joint meeting with the German national engineering society, the Verein Deutscher Ingenieure. Mr. Low is accompanied by Mrs. Low and their son, Giles, and will visit a number of the principal industrial cities in Germany, Great Britain, Switzerland and France before returning to New York the last of August.

Charles A. Carels, chairman of the board of directors of Carels Frères, of Ghent, Belgium, is visiting the United States to arrange for the manufacture of the Carels-Diesel engine in this country. Mr. Carels, as representative of his associates, says they are very strong believers in the possibility of the development of the Diesel engine in the United States and of its commercial future. They have recently employed D. G. Baker, an American engineer, as director-general of production at their plant in Ghent. Mr. Carels is visiting a number of the largest machine builders with a view of buying some additional American tools and equipment for the Ghent plant. At the present time 70 per cent. of their tools are of American manufacture. Mr. Carels is now on a trip to Cleveland, Cincinnati, Detroit and other points.

George R. Croll, general superintendent of mechanical equipment for Thomas Borthwick & Sons, Ltd., Australasia, who is on a tour in this country and Europe, recently spent a week in Chicago inspecting the meat-packing plants. He is in charge of the five Borthwick plants, two in New Zealand and three in Australia, where meats, tallow, wool, etc., are prepared for shipment to England and the Continent.

Mr. Croll stated that the operating conditions throughout Australasia compared very favorably with those prevailing in this country. The eight-hour day is universal. At the plants under his charge the entire engineering force is employed steadily through the year, although the works are shut down annually for several months. During the off-season the men are employed with repairs, renewals, etc. The men are each given a two-weeks' vacation with full pay. They obtain their meats at wholesale prices and usually have a kitchen garden near their homes. The chief engineer is provided with free electric light. All regular overtime work is paid for, but emergency overtime work is cheerfully performed by the men without pay.

As a fine spirit of fair play usually exists between employers and employees, it is not uncommon for men to spend their lives with one concern. Mr. Croll grew up in the meat-export business, starting as an apprentice in operating engineering. He has been a reader of "Power" for 23 years, and encourages his men to read it regularly by providing a copy for each plant. His object is to assist the young men to the more important positions constantly being created by the erection of additional plants. The practice of promoting men already employed by the firm prevails.

OBITUARY

BERNHARD SCHUCHARDT

Bernard Schuchardt, head of the well known firm of Schuchardt & Schütte, died in Berlin, Germany, on June 3, after a brief illness.

Mr. Schuchardt's connection with the machinery-building industry runs back over a period of some 30 years. Early in its experience as international machinery dealers his firm became an influential factor in the export trade of the American machine-tool industry and it steadily grew to include all of the principal markets of the world.

Mr. Schuchardt was consul-general to Norway in Germany and held honorary appointments from the German government. At the time of his death he was 58 years old.

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The Greenfield (Mass.) Electric Loght & Power Co. has contracted with the S. Morgan Smith Co. for three wicket-type turbine water wheels for general light and power service. These are to be used in the Gardner Falls Station, and the two less efficient units already there are to be used only in emergency after the new ones are installed. The latter will be the first concrete scroll case wheels in New England. Water is carried to the wheels through a concrete scroll in a manner similar to that developed in the big Keokuk power plant. Each of these units is a single vertical wheel directly connected to an umbrella type generator operating at 150 r.p.m. Each wheel is rated at 1450 hp. with a 37-ft. head and is 57¼ in. in diameter. The exciter unit is vertical, of 135 hp. at 550 r.p.m., and measures 16½ in.

NEW EQUIPMENT

ATLANTIC COAST STATES

Plans are being prepared by John G. Brown for the construction of a power plant at Ninth St. and Allegheny Ave., Philadelphia, Penn., for the Electric Storage Battery Co.

Plans are being prepared by the Penn Central Light & Power Co. for the construction of a new power plant at Williamsburg, Penn., to have a capacity of 30,000 hp. Warren Partridge, Clearfield, Penn., is general manager.

Plans are being considered by the Cambridge Gas, Electric Light & Power Co. for the installation of new equipment in its power plant at Cambridge, Md. G. Lobo is secretary.

SOUTHERN STATES

Stanley Scott and associates contemplate the construction of an electric-light plant at Eastville, Va.

The Southern Utilities Co., Jacksonville, Fla., is considering plans for the improvement of its various plants. H. C. Adams, Jacksonville, is manager.

Bonds to the amount of $5000 have been voted for the installation of a water system in Passagrille, Fla.

The Ballard & Ballard Co., a Louisville, Ky., is contemplating adding to its electrical equipment by the installation units aggregating 200 hp.

CENTRAL STATES

The Coshocton Light & Heating Co., Coshocton, Ohio, is considering the installation of additional equipment in its plant. C. H. Howell is superintendent.

An election will be held soon at which the proposition to issue $125,000 for the construction of a municipal electric-light plant at Lancaster, Ohio, will be submitted to the voters.

Boilers and other power equimpent will be purchased by the Wood Mosaic Co., New Albany, Ind., for installation in its new sawmill at Highland Park, Ky. The power plant of the mill which was recently destroyed was a total loss.

The city of Portland, Ind., contemplates an expenditure of $4000 for the installation of a new boiler in the municipal electric-light plant. O. O. Clayton is city engineer.

The village of Ahmeek, Mich., contemplates the installation of a water system, to cost $9000.

Bids will be received by Homer Fish, village clerk, Saline, Mich., until June 18, for the construction of a water system. Estimated cost, $30,000. Plans have been prepared by the W. J. Sherman Co., The Nasby, Toledo, Ohio.

Frugale Power Co. is considering plans for the construction of a power plant at Whitehall, Mich. Estimated cost, from $15,000 to $20,000. Frank H. Speese is engineer-in-charge.

Plans are being prepared by the Lewistown Electric Co., Lewistown, Ill., for the installation of additional equipment in its power plant. C. W. King is general manager.

Plans have been prepared by Herman Azzaline, Sr., for the construction of an electric-light plant at Hollandale, Wis.

WEST OF THE MISSISSIPPI

W. T. McVasky & Co. is considering the construction of an electric-light plant at Belmont, Iowa.

The Holstein Service Co. contemplates the construction of an electric-light plant at Holstein, Iowa. W. F. Hutton is secretary.

W. A. Curtis contemplates the installation of an electric-light plant at Maxwell, Iowa.

The Mediapolis Electric Co. has been granted a franchise to construct and operate an electric-light plant at Mediapolis, Iowa.

At a recent election it was voted to construct a municipal electric-light plant, at Russell, Iowa.

On May 24 the electric-light plant of the Warfield Electric Co., at Bemidji, Minn., was destroyed.

Bonds for $30,000 have been voted for the construction of an electric-light plant and water system at Warroad, Minn.

WANTS

Positions Wanted, three cents per word, each insertion
Positions Open, five " " " " "
For Sale, five " " " " "
Miscellaneous, ten " " " " "
No abbreviated words allowed.
Count three words for keyed address.
All advertisements payable in advance.

Copy should reach us not later than Tuesday 10 A. M., for ensuing week's issue. Answers addressed to our care, 505 Pearl St., New York, will be forwarded.
No information given by us regarding any advertiser's address. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondent.
No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for positions.

POSITIONS OPEN

SALESMAN—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M.M. Co.," Power.

CHIEF ENGINEER for central station of about 10,000 kw. capacity in the East; turbines and reciprocating engines; must be able to handle men, keep plant details of experience and state minimum salary. P. O. 911, Power.

A HUSTLER, well known to structural-steel engineers and contractors, to sell high-grade metal paint; acceptable opening for an energetic man who can get results. The Atlas Paint Co., 101 Park Ave., N. Y. (Apply in forenoon.)

AGENTS to sell on commission mechanical draft blowers; prefer men who handle on similar basis sales of grate bars, tube cleaners or other boiler accessories; hustlers wanted; state experience and territory worked. P. 855, Power.

AT ONCE, TWO GOOD ENGINEERS and one chief engineer for 1500-hp. electric light and power plant located in Pennsylvania; applicants must be familiar with turbines and switchboards; state experience, age and salary expected in first letter. P. O. 910, Power.

POSITIONS WANTED

ERECTING FLOOR FOREMAN by an erecting engineer, at present employed on large size units. P. W. 916, Power.

BY LICENSED STEAM ENGINEER, refrigerating or electric; best of experience and reference; executive ability; now employed. P. W. 909, Power.

A TECHNICAL MAN wants position as superintendent of an electric-lighting and refrigerating plant; age 34; good reasons for changing. P. W. 915, Power.

NEW YORK REPRESENTATIVE OF STEAM SPECIALTIES wishes some more representations, also sole agencies of England. Gillett, 301 West 17th St., New York.

DISTRICT STEAM HEATING thoroughly understood by practical mechanic; at present in charge of steam and condensation meter department, desires to make change. P. W. 918, Power.

CHIEF ENGINEER; will be open July 1; 13 years' experience in railway power plant, eight years in manufacturing plant; strictly sober; can refer to present employer. P. W. 913, Power.

A MECHANICAL ENGINEERING GRADUATE wants position as superintendent of power, or master mechanic with a manufacturing firm; 11 years' varied experience; now employed. P. W. 914, Power.

BY AN ELECTRICAL, MECHANICAL AND EFFICIENCY ENGINEER, who has had 20 years' experience in teaching, designing, constructing, operating and managing; graduate Cornell, and member American Society of Mechanical Engineers. P. W. 912, Power.

MANUFACTURERS REPRESENTATIVE, favorably known and of wide experience in modern engineering, wishes to handle power-plant equipment, engines, boilers, stokers, etc., in Pittsburgh district. Daniel Ashworth, M. E., 1225 Fulton Bldg., Pittsburgh, Penn.

REFRIGERATION ENGINEER, total abstainer, has served two years as chief, desires position as chief in either absorption or compression plant; good boiler economy and machine capacity guaranteed; Middle West or South preferred; less than $125 not considered; good references. P. W. 906, Power.

FOR SALE

22x48 BROWN CORLISS TYPE ENGINE, perfect condition. $675. Duzets & Son, Hudson Terminal, New York.

20x42 HUGHES & PHILLIPS tangye frame Corliss engine; cost $4000; like new; $1200. Duzets & Son, Hudson Terminal, New York.

20x42 LANE & BODLEY HEAVY DUTY CORLISS ENGINE; condition like new; $900. Eastern Machinery Exchange, 171 Broadway, New York.

GAS ENGINE, 225 hp. American Crossley horizontal double cylinder, opposed 22x30 in., with Akerlund producer; located Columbia, S. C.; selling account cheap hydro-electric power; bargain. F. S. 904, Power.

ENGINES AND BOILERS, 12x36 St. Louis Cor., 14x36 St. Louis Cor., 26x48 Fil. & S., 26x42x48 Cross Compound, $1400, 2-250 HP. Heine Boilers, 2-180 HP. Heine Boilers, 2-72x18 Boilers. Send for complete list of Engines, Boilers, Generators, Motors, etc. Harold R. Wilson Machinery Co., St. Louis.

GAS ENGINE—One Foos vertical 15x20-in. three-cylinder producer-gas engine, 150 brake hp., speed 225 r.p.m., connected to S-5½-E, 100 kw., 250-volt, compound-wound, direct-current Western Electric generator with field rheostat; approximate weight, 49,000 lb.; good condition; very moderate use for about two years. F. S. 917, Power.

ONE 10x16-IN IDEAL TANDEM COMPOUND CENTER CRANK STEAM ENGINE, 100 i.hp. at 270 r.p.m.; high-pressure cylinder has piston valve, low-pressure cylinder, balanced slide valve, operated from inertia type shaft governor; flywheel 5 ft. 8 in., 15-in. face; steam pipe, 4 in.; exhaust, 5 in.; shaft, 5½ in.; over-all dimensions, 5x11 ft. 7 in.; one 10x9 simple junior Westinghouse engine; capacity, 50 i.hp. at 335 r.p.m.; flywheel, 3 ft. 6 in. diameter, no belt wheel; steam pipe 3½ in.; exhaust 4 in.; shaft, 3⅜ in.; over-all dimensions, 3 ft. 8 in. by 7 ft. 2 in. For further information concerning these engines address James M. White, supervising architect, University of Illinois, Urbana, Ill.

MISCELLANEOUS

PATENTS SECURED—C. L. Parker, Patents 904 G St. Washington, D. C.

WANTED—One 350- to 400-hp. high-pressure boiler. Address Wausau Box & Lumber Co., Wausau, Wis.

WANTED—Additional capital for Lawrence Mfg. Co., lately incorporated to manufacture and exploit new inventions patented in the U. S., Canada and England; for particulars address: Lawrence Mfg. Co., Key West, Fla., or George Hiram Mann., 71 Wall St., New York.